

Q
11
U563
CRLSSI





SHOUT
SHARE **IT**

SMITHSONIAN
INSTITUTION

MUSEUM
OF
NATURAL
HISTORY

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price \$1.50 (paper cover)

521-1
02
UNITED STATES NATIONAL MUSEUM BULLETIN 285

Two FORTRAN II Programs for the Univariate and Bivariate Analysis of Morphometric Data

THOMAS R. WALLER



SMITHSONIAN INSTITUTION PRESS
CITY OF WASHINGTON

1968

Publications of the United States National Museum

The scientific publications of the United States National Museum include two series, *Proceedings of the United States National Museum* and *United States National Museum Bulletin*.

In these series are published original articles and monographs dealing with the collections and work of the Museum and setting forth newly acquired facts in the fields of anthropology, biology, geology, history, and technology. Copies of each publication are distributed to libraries and scientific organizations and to specialists and others interested in the various subjects.

The *Proceedings*, begun in 1878, are intended for the publication, in separate form, of shorter papers. These are gathered in volumes, octavo in size, with the publication date

of each paper recorded in the table of contents of the volume.

In the *Bulletin* series, the first of which was issued in 1875, appear longer, separate publications consisting of monographs (occasionally in several parts) and volumes in which are collected works on related subjects. *Bulletins* are either octavo or quarto in size, depending on the needs of the presentation. Since 1902, papers relating to the botanical collections of the Museum have been published in the *Bulletin* series under the heading *Contributions from the United States National Herbarium*.

This work forms number 285 of the *Bulletin* series.

Frank A. Taylor
Director, United States National Museum

Contents

	Page
Abstract	1
Introduction	1
Statistics.	3
DASAN: Description of Program	4
Listing of FORTRAN II Statements in DASAN	8
Input Data Preparation for DASAN	23
Alternative Statements and Subroutines for DASAN	28
Sample Input Data for DASAN	28
Sample Output from DASAN	30
Error Messages in DASAN	38
VPLOT: Description of Program	38
Listing of FORTRAN II Statements in VPLOT	39
Input Data Preparation for VPLOT	49
Sample Input Data for VPLOT	50
Sample Output from VPLOT	51
Error Messages in VPLOT	54
Availability of Program Decks	54
Literature Cited	55

Two FORTRAN II Programs for the Univariate and Bivariate Analysis of Morphometric Data

Abstract

Two computer programs, written in FORTRAN II for the IBM 7094, perform univariate and bivariate analyses of morphometric data and plot bivariate scatter diagrams of pairs of data. Basically, the programs are designed to process arrays in which rows (up to 100) represent specimens and columns (up to 52) represent measured and computed variables. Alternatively, an input array may represent a single organism, for example a coiled snail or a segmented arthropod, with the rows representing, respectively, individual whorls or segments. A high degree of adaptability to different kinds of problems is achieved because of the numerous control cards which specify input and output format, table headings, and column numbers of variables on which operations are to be performed.

Program devices allow for the elimination of zeroes representing missing data and for the conversion of selected columns to logarithms to the base 10. The computed univariate statistics include the maximum, minimum, observed range, arithmetic mean, standard deviation, standard error of the mean, and coefficient of variation. Bivariate statistics include the correlation coefficient, slopes and intercepts of either regression lines or the reduced major axis, coefficients of relative dispersion, and factors for the computation of confidence intervals. Finally, the programs plot selected pairs of data on bivariate scatter diagrams and furnish the end points for the plotting of regression lines or reduced major axes.

Introduction

Morphometry, or the measurement of form, is becoming increasingly important in the study of fossil and living organisms. The uses and limitations of univariate and bivariate techniques in the analysis of morphometric data in paleontology have been summarized by Imbrie (1956), and the application of such analytic techniques in zoology has been described by Simpson, Roe, and Lewontin (1960).

In paleontology, it is often necessary to deal with fragmentary specimens in order to obtain samples (groups of specimens) which are large enough to be statistically treated. If the missing data are represented by zeroes, these zeroes must be eliminated from any statistical analysis. Furthermore, if the data are transformed to logarithms, a zero representing the logarithm of one to the base ten must be treated statistically and must therefore be differentiated from a zero representing missing data.

Examples of other operations which may be required in morphometric work are as follows:

1. Subtract the thickness of a measuring platform from a measurement where, in order to obtain the measurement, this thickness had to be included.
2. Convert certain measurements, which are invariably in ocular micrometer units, to millimeters.
3. Convert certain measurements, which are in ocular micrometer units only when the specimen is small, to millimeters.
4. Compute the cross-sectional area of a muscle or ligament, where such an area can be approximated by a simple formula, e.g., the area of a circle or a triangle.
5. Compute measurements which are the sums or differences of other measurements.
6. Convert any or all measurements to logarithms.
7. Compute ratios of one measurement to another.
8. Arrange data in order of decreasing size of one of the measurements and/or preserve the order of specimens in the input.

9. Construct bivariate scatter diagrams of ratios and compute regression lines or lines of best fit.

The programs described here, for use on the IBM 7094,

perform all of these operations. In addition, they punch out the final measurements and ratios and print out the statistics listed in Table 1.

TABLE 1.—Symbols and Formulae for Statistics Computed by Data Assembly and Analysis (DASAN)
(x or y = any variate; *see section on statistics)

Statistics	Output Symbol	FORTTRAN Symbol	Math Symbol	Formula
<i>Univariate Statistics</i>				
Number of non-zero values or pairs of values	NUM.	NUMBER	N	-----
Maximum value	MAX.	AMAX	x_1	-----
Minimum value	MIN.	AMIN	x_2	-----
Observed range	RANGE	RANGE	OR_x	$OR_x = x_1 - x_2$
Arithmetic mean	MEAN	AMEAN	$\bar{x}$	$\bar{x} = \frac{\sum x}{N}$
Standard deviation	STDDV	STDDV	s_x	$s_x = \sqrt{\frac{\sum (x - \bar{x})^2}{N - 1}}$
Standard error of the mean	SDVMN	SDVMN	$\sigma_{\bar{x}}$	$\sigma_{\bar{x}} = \frac{s_x}{\sqrt{N}}$
Coefficient of variation	V	V	V	$V = \frac{100 s_x}{\bar{x}}$
<i>Bivariate Statistics (Routine #1)</i>				
Correlation coefficient	R	R	r	$r = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sqrt{\sum (x - \bar{x})^2 \sum (y - \bar{y})^2}}$
Slope of reduced major axis	A	A	a	$a = \frac{s_y}{s_x}$
Standard error of A	SIG(A)	STERRA	σ_a	$\sigma_a = a \sqrt{\frac{1 - r^2}{N}}$
y -intercept of reduced major axis	B	B	b	$b = \bar{y} - \bar{x}a$
Coefficient of relative dispersion from reduced major axis	D(RMA)	DRMA	D	$D = \sqrt{\frac{2(1 - r)(s_x^2 + s_y^2)}{\bar{x}^2 + \bar{y}^2}} \cdot 100$
Arithmetic mean of y	MEAN Y	AMEANY	$\bar{y}$	-----
Arithmetic mean of x	MEAN X	AMEANX	$\bar{x}$	-----
Ordinate of point at which reduced major axis crosses maximum value of x on scale of a plot printed by VPLOT	YMAX 1	YMAX1		-----
Ordinate of YMAX 1 in scale-units of a plot printed by VPLOT	TOP 1	TOP1		-----
Ordinate of y -intercept in scale-units of a plot printed by VPLOT	BASE 1	BASE1		-----
<i>Bivariate Statistics (Routine #2)</i>				
Correlation coefficient	R	R	r	Same as above.
Slope of regression of y on x	A(YX)	BYX	b_{yx}	$b_{yx} = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sum (x - \bar{x})^2}$
Y -intercept of regression of y on x	B(Y)	AY	a_y	$a_y = \bar{y} - b_{yx}\bar{x}$
Slope of regression of x on y	A(XY)	BXY	b_{xy}	$b_{xy} = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sum (y - \bar{y})^2}$
X -intercept of regression of x on y	B(X)	AX	a_x	$a_x = \bar{x} - b_{xy}\bar{y}$
Standard error of estimate in y direction	S(Y.X)	STESTY	s_{yx}	$s_{yx} = s_y \sqrt{1 - r^2}$
Standard error of estimate in x direction	S(X.Y)	STESTX	s_{xy}	$s_{xy} = s_x \sqrt{1 - r^2}$
Coefficient of relative dispersion from regression of y on x	D(Y.X)	DYX	D_{yx}	$D_{yx} = \frac{100 s_{yx}}{\bar{y}}$
Standard error of D(Y.X)	S(DYX)	ERRDYX	$\sigma_{D_{yx}}$	$\sigma_{D_{yx}} = \frac{D_{yx}}{\sqrt{2N}}$

TABLE 1.—Symbols and Formulae for Statistics Computed by Data Assembly and Analysis (DASAN) (*Continued*)
(*x* or *y* = any variate; *see section on statistics)

Statistics	Output Symbol	FORTTRAN Symbol	Math Symbol	Formula
Coefficient of relative dispersion from regression of <i>x</i> on <i>y</i>	D(X.Y)	DXY	D_{xy}	$D_{xy} = \frac{100 s_{xy}}{\bar{x}}$
Standard error of D(X.Y)	S(DXY)	ERRDXY	$\sigma_{D_{xy}}$	$\sigma_{D_{xy}} = \frac{D_{xy}}{2N}$
Factor for computing a confidence interval of A(YX)*	CONAYX	CONBYX	CA_{yx}	$CA_{yx} = \frac{s_{xy}}{s_y \sqrt{N-1}}$
Factor for computing a confidence interval of B(Y)*	CONBY	CONAY	CB_y	$CB_y = \frac{s_{yx}}{\sqrt{N}}$
Factor for computing a confidence interval of A(XY)*	CONAXY	CONBXY	CA_{xy}	$CA_{xy} = \frac{s_{xy}}{s_x \sqrt{N-1}}$
Factor for computing a confidence interval of B(X)*	CONBX	CONAX	CB_x	$CB_x = \frac{s_{xy}}{\sqrt{N}}$

Basically, the programs are designed to process arrays of data in which rows represent specimens and columns represent measured and computed variables. Alternatively, an input array may represent a single organism, for example, a coiled snail or a segmented anthropod, with the rows representing, respectively, individual whorls or segments. A high degree of adaptability to different kinds of problems is achieved because of the numerous control cards which specify input and output format, table headings, and column numbers of variables on which operations are to be performed.

The first program, referred to here as DASAN (Data Assembly and Analysis), computes the output arrays and all statistics; the second program, referred to as VPLOT (Variable Plotting), plots the bivariate scatter diagrams, using the punched output deck from DASAN as input.

Background and Acknowledgments.—The initial versions of the programs described here were lengthy and were designed for the author's own research concerned with the morphometric analysis and phylogenetic interpretation of a closely-knit group of species within the Pectinidae (Mollusca: Bivalvia). Interest expressed by others made clear

the value of revising the programs so that they would be adaptable to a wide variety of problems.

The reprogramming was carried out at the Smithsonian Institution, Washington, D.C., as part of a continuing project concerned with the paleobiology of the Pectinidae, which is supported by a grant from the Smithsonian Research Foundation. Use of the IBM 7094 of the Columbia University Computer Center was made possible through the generosity of Dr. John Imbrie of the Department of Geology. Invaluable assistance in constructing the initial programs, particularly in incorporating the variable plotting routine (Subroutine APLOT), was received from D. M. Vincent Manson of the American Museum of Natural History. The APLOT subroutine originally appeared in a program written by Clarence Bradford and Arthur Gasche of the University of Chicago and has subsequently been adapted to a number of programs by Manson. Constructive suggestions regarding both programs and texts have been gratefully received from Alan Cheetham of the Smithsonian Institution, Stephen Jay Gould of Harvard University, and Niles Eldredge of Columbia University.

Statistics

The statistics appearing in the output of DASAN are computed by means of the formulae shown in Table 1, all of which have been taken from either Imbrie (1956) or Simpson, Roe, and Lewontin (1960). In addition to their use in summarizing data and in the drawing of regression lines or lines of best fit directly onto the output of VPLOT, the statistics are of use in the construction of modified Dice-Leraas diagrams (Simpson et al., p. 355) and in determining whether differences in the position and slope of reduced major axes are statistically significant (Imbrie, p. 237).

Using the factors marked by asterisks in Table 1, confidence intervals (CI) for the slopes and intercepts of regression lines may be calculated as follows, where *t* is the familiar Student's *t* with *N*—2 degrees of freedom and other symbols are the mathematical symbols of Table 1:

$$CI_{b_{yx}} = b_{yx} \pm CA_{yx}t$$

$$CI_{a_y} = a_y \pm CB_yt$$

$$CI_{b_{xy}} = b_{xy} \pm CA_{xy}t$$

$$CI_{a_x} = a_x \pm CB_xt$$

DASAN: Description of Program

Construction and Handling of Arrays.—The construction and handling of arrays by DASAN is illustrated in Figure 1. Note that the input, referred to as the *univariate input array*, contributes to and becomes part of a *univariate output array*. The latter consists of the univariate input array plus any new variables, *other than ratios*, which are computed from the input variables. All of the variables represented in the univariate output array may therefore not be univariate in a mathematical sense, but they serve here as the data for a statistical analysis which yields the univariate statistics listed in the introduction. The *bivariate array* consists only of form ratios, which are computed from pairs of variables drawn from the univariate output array.

In each of the three arrays, the first variable (first column) consists of specimen identification numbers, with the remaining variables consecutively numbered from left to right beginning with variable No. 2.

In the schematic problem illustrated in Figure 1, the univariate input array, containing a column of specimen numbers (*a*) and five columns of measurements (*b* through *f*), becomes a subarray (*A*) within the univariate output array. Two of the original variables, *d* and *f*, are modified so that

$$d' = \frac{d}{10.18}$$

and

$$f' = f - 9.45$$

where 10.18 and 9.45 are constants specified on control cards.

Four new subarrays have been generated and included in the univariate output array. The subarray *B* contains two variables, *g* and *h*, where

$$g = \frac{b \cdot c}{2}$$

and

$$h = d' \cdot e$$

These are special computations made possible by the insertion of special statements in DASAN, as described in a following section. Subarray *C* consists of variables generated by subtracting one of the variables in the preceding columns from another. Let us suppose that here

$$i = b - e$$

and

$$j = b - f$$

Subarray *D* consists of variables generated by adding any two of the variables in the preceding columns. For example,

$$k = e + h$$

Subarray *E* consists of the logarithms (base 10) of variables in the preceding columns. For example,

$$l = \log_{10} b$$

and

$$m = \log_{10} c$$

Univariate statistics for all of the variables (except for the specimen identification numbers) in the univariate output array are computed. Both univariate and bivariate statistics are computed for the variables in the bivariate array.

In addition to the bivariate statistics which are computed for each variable (ratio) in the bivariate array, an option exists whereby a bivariate analysis of *x* and *y* transformed to logarithms (base 10) may be performed for certain columns, the column numbers of which are specified on a control card. Let us suppose that in the sample problem illustrated in Figure 1 a control card specifies that the variables comprising the ratios appearing in columns 2, 3, 5, 6, and 8 in the bivariate array are to be transformed to logs for an additional bivariate analysis. These statistics appear in Array IV. The wavy lines beneath the ratios *f'/c*, *j/d'*, and *l/m* mark those variables which were *not* designated for logarithmic transformation and for which the bivariate statistics from Array III are merely repeated (with the exception of the coordinates of the end points of the lines of best fit or regressions, which have been altered and are no longer valid).

In the bivariate array for this same sample problem, the ratio *l/m* is the ratio of one log ($\log b$) to another ($\log c$). Such ratios which are constructed from variables previously transformed to logarithms in the univariate output array cannot be processed to yield correct univariate and bivariate statistics. These invalid statistics are indicated by a wavy line in Arrays II and III. Note that correct bivariate statistics for this same ratio ($\log b / \log c$) appear under *b/c* in Array IV.

If the horizontal dimension of an output array exceeds the width of standard output paper, the array must be broken into segments, each of which can be printed on the computer paper. This has been done in the sample output (see listing of sample output).

Flow of Control.—The flow of control through DASAN is schematically represented in Figure 2, and the main steps followed by the program during an execution involving all subroutines are listed below:

DASAN (main)

1. Control cards, variable formats, and data are read in.
2. Subroutine RAWTAB is called if so indicated by option.

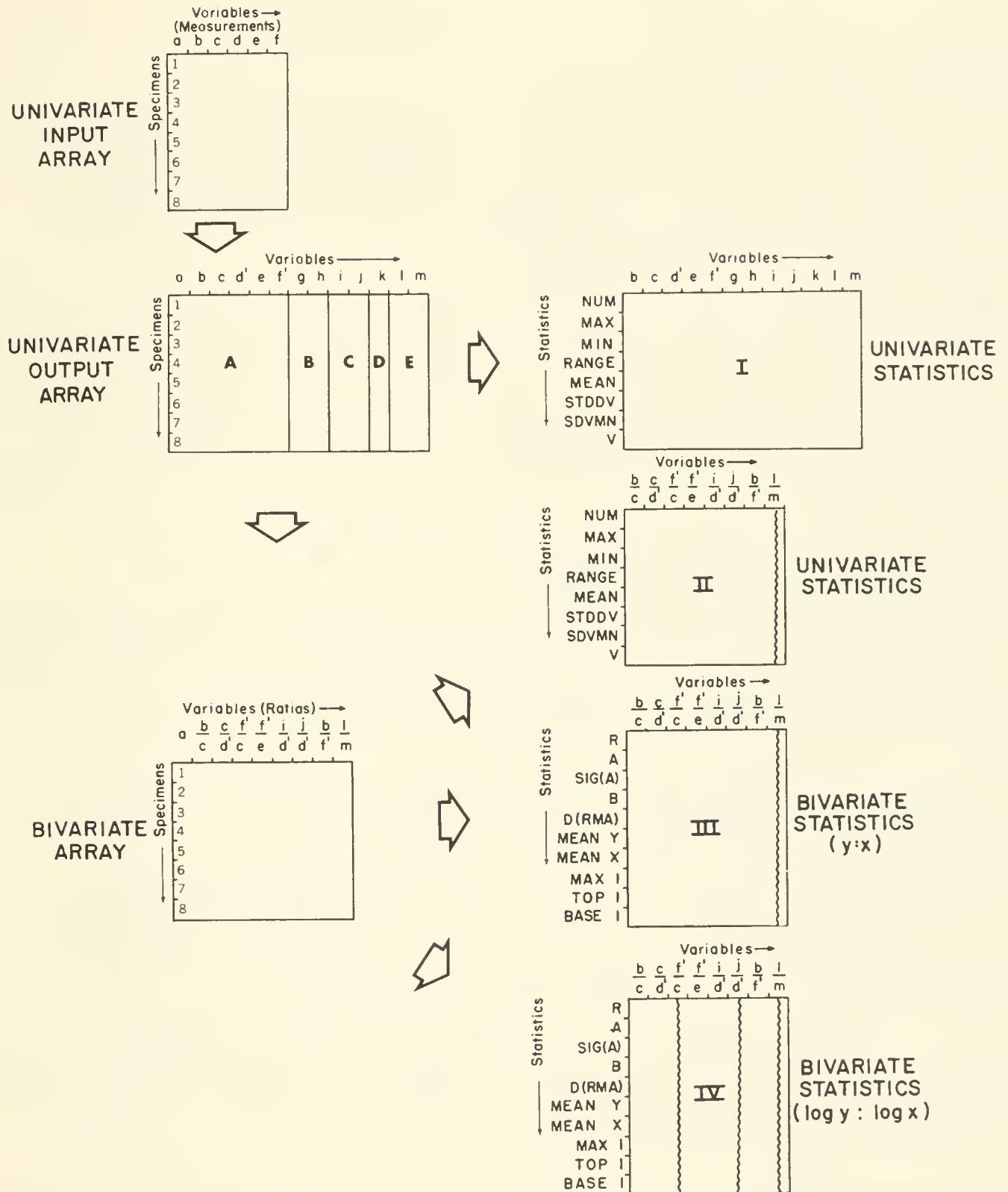


FIGURE 1.—Construction of arrays by DASAN for a sample problem. (Abbreviations and construction procedures are explained in the description of the program. The bivariate statistics shown here are for the reduced major axis.)

Subroutine RAWTAB

Each of the following steps in RAWTAB is optional, depending upon values on control cards.

3. A read-in constant is subtracted from certain columns of variables, the column numbers of which are specified on control cards. The results replace the original values.

4. Certain variables, the column numbers of which are specified on control cards, are divided by a read-in constant. The results replace the original values.

5. If so indicated by signals on each data card, certain data cells, the column numbers of which are specified on control cards, are divided by a read-in constant. The results replace the original values.

6. Special variables are computed (e.g., the areas of muscle attachments). The results are new columns of variables which are added to the original data array.

7. Certain variables, specified on control cards, are subtracted from certain other variables, also specified on control cards. The results are new columns of variables added to the univariate input array.

8. Same as Step 7, but involving the addition of variables.

9. Certain variables, specified on control cards, are converted to logarithms to the base 10. The logs are added to the univariate input array as columns of new variables.

10. Control is returned to the main program.

DASAN (main)

11. Subroutine XRATIO is called, if so indicated by option.

Subroutine XRATIO

12. Ratios are computed and entered in a new array. The column numbers of variables comprising the ratios are specified on control cards.

13. Control is returned to the main program.

DASAN (main)

14. If so indicated by option, subroutine XPUNCH is called.

Subroutine XPUNCH

15. The univariate output array is punched onto cards according to format specified on control cards.

16. Control is returned to the main program.

DASAN (main)

17. If so indicated by option, the first page of the univariate output array is printed with no change in the

order of specimens in the input deck.

18. Subroutine UNIVAR is called.

Subroutine UNIVAR

19. Univariate statistics are computed from the variables which are to appear on one page of output.

20. The univariate statistics are printed out below the page of the univariate output array.

21. Control is returned to the main program.

DASAN (main)

22. If no more univariate output pages remain to be printed, the option to proceed to the first page of bivariate output is interrogated. If more pages of the univariate output array remain to be printed, the next page is printed out, followed by a call to UNIVAR and printing out of the univariate statistics as in Steps 17 through 21.

23. If so indicated by option, the first page of the bivariate array is printed out, with no change in the order of specimens in the input deck.

24. Subroutine UNIVAR is called.

Subroutine UNIVAR

25. Univariate statistics are computed from the bivariate variables on a page of output.

26. The univariate statistics are printed out below the page of the bivariate array.

27. Control is returned to the main program.

DASAN (main)

28. Subroutine BIVAR is called.

Subroutine BIVAR

29. Bivariate statistics are computed for the ratios appearing on one page of the bivariate array.

30. The bivariate statistics are printed out below the univariate statistics.

31. Bivariate statistics for $\log_{10}y$ and $\log_{10}x$ are computed for any or all of the ratios, as instructed by control cards.

32. The bivariate statistics of the log data are printed out below the bivariate statistics of the non-log data.

33. Control is returned to the main program.

DASAN (main)

34. The number of bivariate output pages is checked. If more remain to be printed, Steps 23 through 33 are repeated.

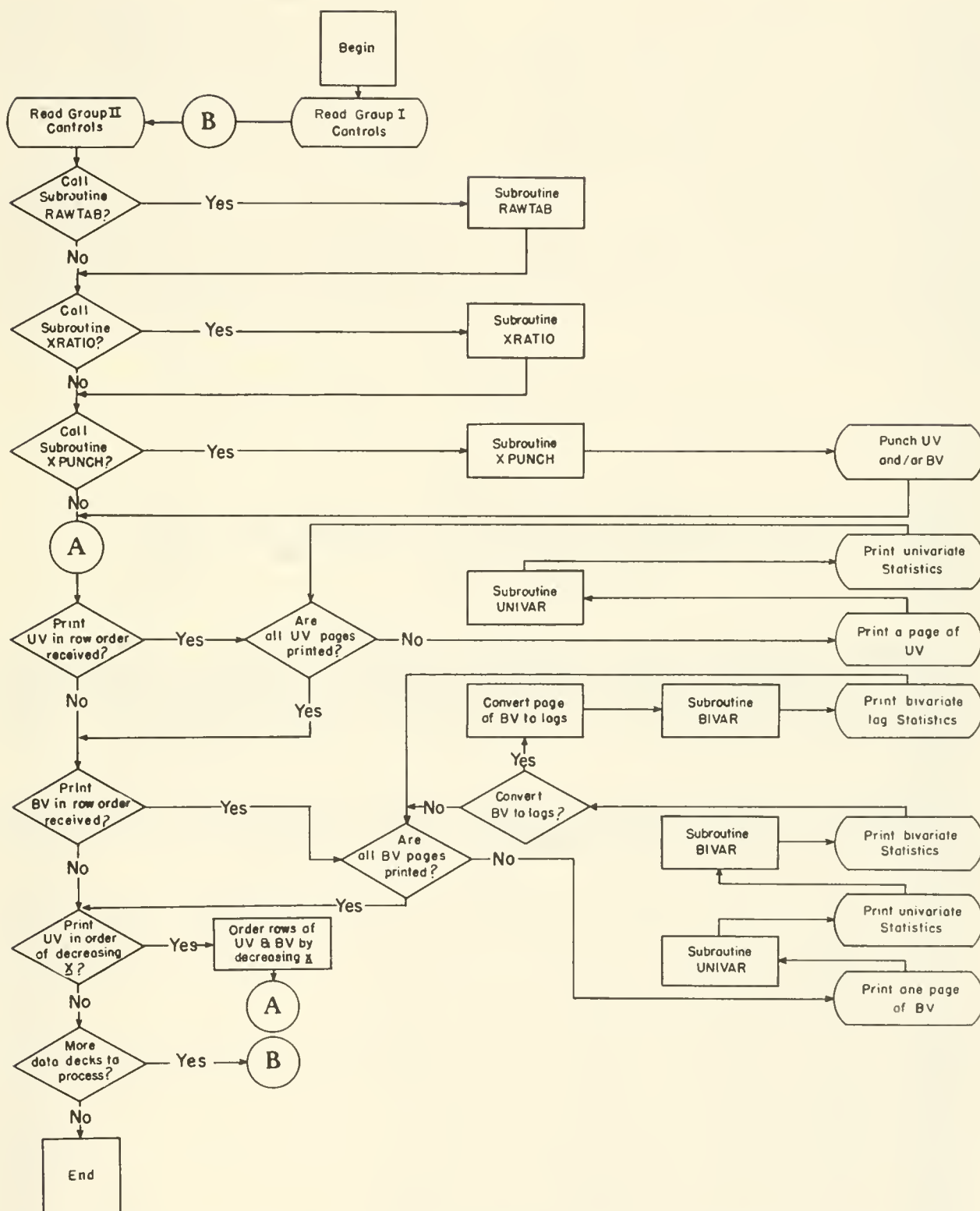


FIGURE 2.—Simplified block diagram showing the flow of control through DASAN and the major output options. The abbreviations *UV* and *BV* refer, respectively, to the univariate output array and the bivariate array. *A* and *B* indicate points between which flow lines cannot be conveniently drawn.

35. If no more bivariate output pages remain, the option to print all data in order of decreasing values of one of the variables, the column number of which is indicated on a control card, is interrogated. If so indicated, Steps 17 through 34 are repeated (flow returns to connecting point A in Figure 2) with an option to print the bivariate array in order of decreasing values of a specified variable replacing the option referred to in Step 23.

36. If more data decks remain to be processed, control is passed back to Step 1 (connecting point B in Figure 2) with the reading in of new Group-II control cards (see section on input data preparation) and data. Otherwise the execution is completed.

Computation Time.—The test run of DASAN (binary) on the IBM 7094, which used the input and furnished the output listed and described in following sections, analyzed 12 specimens, with 28 variables in the input array, 36 variables in the univariate output array, and 42 variables in the bivariate array, in 52 seconds.

Core Space.—DASAN in its present form approaches the maximum storage allowed in the IBM 7094. Increasing the dimensions so that up to 150 rather than only 100 specimens can be included in a sample resulted in an overlap of COMMON and PROGRAM storage areas. The maximum capacity of the program (in terms of numbers of specimens) which can be reached through redimensioning is therefore between 100 and 150.

Listing of FORTRAN II Statements in DASAN

```

C -----
C               DASAN (MAIN ROUTINE)
C   PROGRAM FOR THE ASSEMBLY AND ANALYSIS OF MORPHOMETRIC DATA
C   THOMAS R. WALLER, DEPT. OF PALEOBIOLOGY, SMITHSONIAN INSTITUTION
C               FEBRUARY 6, 1967
C -----
C
C   DIMENSION ANAME(21),FMT1(60),FMT2(60),FMT3(60),FMT4(60),FMT5(60). DMAIN 1
C   1FMT6(60),FMT7(60),FMT8(96),IDADD1(30),IDADD2(30),IDGLAS(30),IDLOG(DMAIN 2
C   230),IDMIN(30),IDMTR1(30),IDMTR2(5),IDSUBT(30),INDXBV(80,4),MMTRNS(DMAIN 3
C   3100,5),RATIO(100,56),RAW(100,53),SPMAX(53),TEMP1(53),TEMP2(56),      DMAIN 4
C   4VNAME(10,24),SLGMIN(53)                                              DMAIN 5
C
C   COMMON K,RAW,NLOG,NTRNS,GLASS,OCULAR,NGLASS,IDGLAS,NMMTRN,IDMTR1, DMAIN 6
C   1IDMTR2,NSUB,IDMIN,IDSUBT,NADD,IDADD1,IDADD2,IDLOG,NBIVAR,FMT8,FMT2DMAIN 7
C   2,FMT3,FMT6,FMT7,SPMAX,RATIO,INDXBV,MMTRNS,SLGMIN,NBVT              DMAIN 8
C
C   READ INPUT TAPE 5,34,NDATA,L,NUVTOT,NBVTOT,NRTAB,NRAT              DMAIN 9
C   READ INPUT TAPE 5,36,NGLASS,NMMTRN,NTRNS,NSUB,NADD,NLOG           DMAIN 10
C   IF (NGLASS)30,56,55                                                  DMAIN 11
C   55 READ INPUT TAPE 5,36,(IDGLAS(J),J=1,NGLASS)                     DMAIN 12
C   56 IF (NMMTRN)30,58,57                                               DMAIN 13
C   57 READ INPUT TAPE 5,36,(IDMTR1(J),J=1,NMMTRN)                     DMAIN 14
C   58 IF (NTRNS)30,60,59                                                DMAIN 15
C   59 READ INPUT TAPE 5,36,(IDMTR2(J),J=1,NTRNS)                       DMAIN 16
C   60 IF (NSUB)30,62,61                                                 DMAIN 17
C   61 READ INPUT TAPE 5,36,(IDMIN(J),J=1,NSUB)                         DMAIN 18
C   READ INPUT TAPE 5,36,(IDSUBT(J),J=1,NSUB)                           DMAIN 19
C   62 IF (NADD)30,64,63                                                 DMAIN 20
C   63 READ INPUT TAPE 5,36,(IDADD1(J),J=1,NADD)                         DMAIN 21
C   READ INPUT TAPE 5,36,(IDADD2(J),J=1,NADD)                           DMAIN 22
C   64 IF (NLOG)30,66,65                                                 DMAIN 23
C   65 READ INPUT TAPE 5,36,(IDLOG(J),J=1,NLOG)                         DMAIN 24
C   66 READ INPUT TAPE 5,36,NUVAR,NPAGE1                                DMAIN 25

```

READ INPUT TAPE 5,36,NBIVAR,NPAGE2	DMAIN 26
IF (NBVTOT)30,68,67	DMAIN 27
67 NBVT = NBVTOT - 1	DMAIN 28
READ INPUT TAPE 5,36,((INDXBV(I,J),J=1,4),I=1,NBVT)	DMAIN 29
68 NPTOT = NPAGE1 + NPAGE2	DMAIN 30
READ INPUT TAPE 5,37,((VNAME(I,J),J=1,24),I=1,NPTOT)	DMAIN 31
C	
READ INPUT TAPE 5,36,NFMT1,NFMT2,NFMT3,NFMT4,NFMT5,NFMT6,NFMT7,	DMAIN 32
1NFMT8	DMAIN 33
KK = 12 * NFMT1	DMAIN 34
READ INPUT TAPE 5,37,(FMT1(I),I=1,KK)	DMAIN 35
KK = 12 * NFMT2	DMAIN 36
READ INPUT TAPE 5,37,(FMT2(I),I=1,KK)	DMAIN 37
KK = 12 * NFMT3	DMAIN 38
READ INPUT TAPE 5,37,(FMT3(I),I=1,KK)	DMAIN 39
KK = 12 * NFMT4	DMAIN 40
READ INPUT TAPE 5,37,(FMT 4(I),I=1,KK)	DMAIN 41
KK = 12 * NFMT5	DMAIN 42
READ INPUT TAPE 5,37,(FMT5(I),I=1,KK)	DMAIN 43
KK = 12 * NFMT6	DMAIN 44
READ INPUT TAPE 5,37 FMT6(I),I - 1,KK)	DMAIN 45
KK = 12 * NFMT7	DMAIN 46
READ INPUT TAPE 5,37,(FMT7(I), I - 1,KK)	DMAIN 47
KK = 12 * NFMT8	DMAIN 48
READ INPUT TAPE 5,37,FMT8(I),I=1,KK)	DMAIN 49
C	
READ INPUT TAPE 5,FMT2,(SPMAX(J),J=1,NUVTOT)	DMAIN 50
READ INPUT TAPE 5,FMT2,(SLGMIN(J),J=1,NUVTOT)	DMAIN 51
1 READ INPUT TAPE 5,38,PUNCH,WRITE1,WRITE2,RITH1,RITH2,NORDER	DMAIN 52
READ INPUT TAPE 5,37,ANAME	DMAIN 53
READ INPUT TAPE 5,39,GLASS,OCULAR,ISIDE,K	DMAIN 54
IF (NTRNS)30,46,47	DMAIN 55
46 READ INPUT TAPE 5,FMT1,((RAW(I,J),J=1,L),I=1,K	DMAIN 56
GO TO 51	DMAIN 57
47 READ INPUT TAPE 5,FMT1,((MMTRNS(I,J),J=1,NTRNS),(RAW(I,J),J=1,L),	IDMAIN 58
1=1,K)	DMAIN 59
51 IF (NRTAB)30,49,48	DMAIN 60
48 CALL RAWTAB (L,NSPCMP)	DMAIN 61
C	
49 IF (NRAT)30,50,52	DMAIN 62
52 CALL XRATIO (NBVT)	DMAIN 63
C	
50 IF (PUNCH)30,3,2	DMAIN 64
2 CALL XPUNCH (NUVTOT,NBVTOT,PUNCH)	DMAIN 65
C	
3 IF (WRITE1)30,11,4	DMAIN 66
4 NPTEMP = 1	DMAIN 67
NPTOT = 0	DMAIN 68
NV1 = 2	DMAIN 69
NV2 = NUVAR	DMAIN 70
WRITE1 = 0.	DMAIN 71
5 IF (NPAGE1 - NPTEMP)12,6,6	DMAIN 72

	6 NPTOT = NPTOT + 1	DMAIN 73
C	WRITE OUTPUT TAPE 6,40,ANAME	DMAIN 74
C	IF (ISIDE)7,9,8	DMAIN 75
	7 WRITE OUTPUT TAPE 6,41,K	DMAIN 76
	GO TO 10	DMAIN 77
	8 WRITE OUTPUT TAPE 6,42,K	DMAIN 78
	GO TO 10	DMAIN 79
	9 WRITE OUTPUT TAPE 6,43,K	DMAIN 80
C	10 WRITE OUTPUT TAPE 6,45,(VNAME(NPTOT,J),J=1,20)	DMAIN 81
	WRITE OUTPUT TAPE 6,FMT4,(RAW(I,1),(RAW(I,J),J=NV1,NV2),I=1,K)	DMAIN 82
C	CALL UNIVAR (RAW,NV1,NV2,NPTEMP,NUVAR,1,L,NSPCMP,NSUB,NADD)	DMAIN 83
	GO TO 5	DMAIN 84
C	11 NPTOT = NPAGEL	DMAIN 85
	12 IF (WRITE2)30,20,13	DMAIN 86
	13 NPTEMP = 1	DMAIN 87
	NV1 = 2	DMAIN 88
	NV2 = NBIVAR	DMAIN 89
	NPTMP2 = 1	DMAIN 90
	NROW1 = 1	DMAIN 91
	NROW2 = NBIVAR - 1	DMAIN 92
	WRITE2 = 0.	DMAIN 93
	14 IF (NPAGE2 - NPTEMP)20,15,15	DMAIN 94
	15 NPTOT = NPTOT + 1	DMAIN 95
C	WRITE OUTPUT TAPE 6,40,ANAME	DMAIN 96
C	IF (ISIDE)16,18,17	DMAIN 97
	16 WRITE OUTPUT TAPE 6,41,K	DMAIN 98
	GO TO 19	DMAIN 99
	17 WRITE OUTPUT TAPE 6,42,K	DMAIN100
	GO TO 19	DMAIN101
	18 WRITE OUTPUT TAPE 6,43,K	DMAIN102
C	19 WRITE OUTPUT TAPE 6,45,(VNAME(NPTOT,J),J=1,20)	DMAIN103
	WRITE OUTPUT TAPE 6,FMT5,(RATIO(I,1),(RATIO(I,J),J=NV1,NV2),I=1,K)	DMAIN104
C	CALL UNIVAR (RATIO,NV1,NV2,NPTEMP,NBIVAR,2,L,NSPCMP,NSUB,NADD)	DMAIN105
	CALL BIVAR (NROW1,NROW2,NPTMP2)	DMAIN106
	GO TO 14	DMAIN107
C	20 IF (RITHT1)30,22,21	DMAIN108
	21 WRITE1 = 1.	DMAIN109
	22 IF (RITHT2)30,24,23	DMAIN110
	23 WRITE2 = 1.	DMAIN111
	24 IF (RITHT1 + RITHT2) 30,32,25	DMAIN112
C	25 K2 = K - 1	DMAIN113

```

      DO 29 I=1,K2                                DMAIN114
      IP1 = I + 1                                DMAIN115
      DO 29 I2=IP1,K                             DMAIN116
      IF (RAW(I,NORDER) - RAW(I2,NORDER))26,26,29 DMAIN117
26 DO 27 J=1,NUVTOT                               DMAIN118
      TEMP1(J) = RAW(I,J)                       DMAIN119
      RAW(I,J) = RAW(I2,J)                     DMAIN120
27 RAW(I2,J) = TEMP1(J)                         DMAIN121
      DO 28 J=1,NBVTOT                           DMAIN122
      TEMP2(J) = RATIO(I,J)                    DMAIN123
      RATIO(I,J) = RATIO(I2,J)                DMAIN124
28 RATIO(I2,J) = TEMP2(J)                     DMAIN125
29 CONTINUE                                     DMAIN126

C
      R1THT1 = 0.                                DMAIN127
      R1THT2 = 0.                                DMAIN128
      GO TO 3                                     DMAIN129

C
30 WRITE OUTPUT TAPE 6,44                       DMAIN130
      GO TO 33                                   DMAIN131

C
32 NDATA = NDATA - 1                           DMAIN132
      IF (NDATA)33,33,70                       DMAIN133
70 WRITE OUTPUT TAPE 6,71                     DMAIN134
      GO TO 1                                   DMAIN135
33 CALL EXIT                                   DMAIN136

C
34 FORMAT (I3)                                DMAIN137
36 FORMAT (24I3)                              DMAIN138
37 FORMAT (12A6)                              DMAIN139
38 FORMAT (F2.0,4F3.0,I3)                    DMAIN140
39 FORMAT (F6.2/F6.2/I2/I3)                  DMAIN141
40 FORMAT (1H1,21A6)                         DMAIN142
41 FORMAT (1H0,I3,12H LEFT VALVES)           DMAIN143
42 FORMAT (1H0,I3,13H RIGHT VALVES)          DMAIN144
43 FORMAT (1H0,I3,10H SPECIMENS)             DMAIN145
44 FORMAT (1H1,23HANOMALOUS VALVE IN DATA)  DMAIN146
45 FORMAT (1H0,20A6)                         DMAIN147
71 FORMAT (1H1/1H1)                         DMAIN148

C
C
      END

C - - - - - DASAN (SUBROUTINE RAWTAB) - - - - -
C
      SUBROUTINE RAWTAB (L,NSPCMP)              RAWTB 1

C
      DIMENSION DUMMY1(390),DUMMY2(100,56),IDADD1(30),IDADD2(30),IDGLAS(RAWTB 2
130),IDLOG(30),IDMIN(30),IDMTR1(30),IDMTR2(5),IDSUBT(30),MMTRNS(100RAWTB 3
2,5),RAW(100,53),DUMMY3(80,4)                RAWTB 4

C
      COMMON K,RAW,NLOG,NTRNS,GLASS,OCULAR,NGLASS,IDGLAS,NMMTRN,IDMTR1, RAWTB 5
1IDMTR2,NSUB,IDMIN,IDSUBT,NADD,IDADD1,IDADD2,IDLOG,DUMMY1,DUMMY2, RAWTB 6

```

	2DUMMY3,MMTRNS	RAWTB 7
C		
	DO 28 I=1,K	RAWTB 8
C		
	IF (NGLASS)30,4,1	RAWTB 9
1	DO 3 J=1,NGLASS	RAWTB 10
	J2 = IDGLAS(J)	RAWTB 11
	IF (RAW(I,J2))30,3,2	RAWTB 12
2	RAW(I,J2) = RAW(I,J2) - GLASS	RAWTB 13
3	CONTINUE	RAWTB 14
C		
4	IF (NMMTRN)30,7,5	RAWTB 15
5	DO 6 J=1,NMMTRN	RAWTB 16
	J2 = IDMTR1(J)	RAWTB 17
6	RAW(I,J2) = RAW(I,J2) / OCULAR	RAWTB 18
7	IF (NTRNS)30,11,8	RAWTB 19
8	DO 10 J=1,NTRNS	RAWTB 20
	J3 = IDMTR2(J)	RAWTB 21
	IF (MMTRNS(I,J))9,30,10	RAWTB 22
9	RAW(I,J3) = RAW(I,J3) / OCULAR	RAWTB 23
10	CONTINUE	RAWTB 24
C		
11	J4 = L	RAWTB 25
	NSPCMP = 0	RAWTB 26
C		
C	J4 = J4 + 1	RAWTB 27
C	NSPCMP = NSPCMP + 1	RAWTB 28
C		
C	12 RAW(I,J4) = .5 * RAW(I,21) * RAW(I,20)	RAWTB 29
C		
C	ADD ADDITIONAL COMPUTATIONS LIKE STATEMENT NO. 12 IN PLACE OF	
C	THESE COMMENTS. EACH COMPUTATION MUST BE PRECEDED BY J4=J4 + 1 AND	
C	NSPCMP = NSPCMP + 1, AND EACH COMPUTATION STATEMENT BEGINS LIKE	
C	STATEMENT NO. 12. WITH RAW(I,J4) ON LEFT SIDE OF = SIGN. NO STATE-	
C	MENT NUMBERS ARE REQUIRED.	
C		
	IF (NSUB)30,18,13	RAWTB 30
13	DO 17 J=1,NSUB	RAWTB 31
	J2 = IDMIN(J)	RAWTB 32
	J3 = IDSUBT(J)	RAWTB 33
	J4 = J4 + 1	RAWTB 34
	IF (RAW(I,J2))15,14,15	RAWTB 35
14	RAW(I,J4) = 0.	RAWTB 36
	GO TO 17	RAWTB 37
15	IF (RAW(I,J3))16,14,16	RAWTB 38
16	RAW(I,J4) = RAW(I,J2) - RAW(I,J3)	RAWTB 39
17	CONTINUE	RAWTB 40
C		
18	IF (NADD)30,24,19	RAWTB 41
19	DO 23 J=1,NADD	RAWTB 42
	J2 = IDADD1(J)	RAWTB 43
	J3 = IDADD2(J)	RAWTB 44
	J4 = J4 + 1	RAWTB 45

```

      IF (RAW(I,J2))21,20,21
20  RAW(I,J4) = 0.
      GO TO 23
21  IF (RAW(I,J3))22,20,22
22  RAW(I,J4) = RAW(I,J2) + RAW(I,J3)
23  CONTINUE
C
24  IF (NLOG)30,36,25
25  DO 28 J = 1,NLOG
      J2 = IDLOG(J)
      J4 = J4 + 1
      IF (RAW(I,J2))30,28,26
26  RAW(I,J4) = LOG10F(RAW(I,J2))
28  CONTINUE
      GO TO 36
C
30  WRITE OUTPUT TAPE 6,31
31  FORMAT (1H1,23HANOMALOUS VALUE IN DATA)
      CALL EXIT
C
36  RETURN
      END
C - - - - - DASAN (SUBROUTINE XRATIO) - - - - -
C
      SUBROUTINE XRATIO (NBVT)
C
      DIMENSION DUMMY1(613),INDXBV(80,4),RATIO(100,56),RAW(100,53)
C
      COMMON K,RAW,DUMMY1,RATIO,INDXBV
C
      DO 1 I=1,K
      RATIO(I,1) = RAW(I,1)
      J2 = 1
      DO 1 II=1,NBVT
      JY = INDXBV(II,1)
      JX = INDXBV(II,2)
      J2 = J2 + 1
1  RATIO(I,J2) = RAW(I,JY) / RAW(I,JX)
C
      RETURN
      END
C - - - - - DASAN (SUBROUTINE XPUNCH) - - - - -
C
      SUBROUTINE XPUNCH (NUVTOT,NBVTOT,PUNCH)
C
      DIMENSION DUMMY1(320),DUMMY2(173),FMT2(60),FMT3(60),RATIO(100,56),PUNCH
1RAW(100,53)
C
      COMMON K,RAW,DUMMY1,FMT2,FMT3,DUMMY2,RATIO
C
      IF (PUNCH - 2.)1,2,1
1  PUNCH = PUNCH - 1.

```

RAWTB 46
 RAWTB 47
 RAWTB 48
 RAWTB 49
 RAWTB 50
 RAWTB 51
 RAWTB 52
 RAWTB 53
 RAWTB 54
 RAWTB 55
 RAWTB 56
 RAWTB 57
 RAWTB 58
 RAWTB 59
 RAWTB 60
 RAWTB 61
 RAWTB 62
 RAWTB 63
 RAWTB 64
 RATIO 1
 RATIO 2
 RATIO 3
 RATIO 4
 RATIO 5
 RATIO 6
 RATIO 7
 RATIO 8
 RATIO 9
 RATIO 10
 RATIO 11
 RATIO 12
 RATIO 13
 PUNCH 1
 PUNCH 2
 PUNCH 3
 PUNCH 4
 PUNCH 5
 PUNCH 6

C	WRITE OUTPUT TAPE 7,FMT2,((RAW(I,J),J=1,NUVTOT),I=1,K)	PUNCH	7
C	IF (PUNCH - 1.)3,3,2	PUNCH	8
2	WRITE OUTPUT TAPE 7,FMT3,((RATIO(I,J),J=1 NBVTOT),I=1,K)	PUNCH	9
C	3 RETURN	PUNCH	10
	END		
C - - - - - DASAN (SUBROUTINE UNIVAR) - - - - -			
C	SUBROUTINE UNIVAR (XX,N1,N2,NPTMP,NVAR,M,L,NSPCMP,NSUB,NADD)	UV	1
C	DIMENSION AMAX(20),AMEAN(20),AMIN(20),ANUM(20),BNUM(20),DIFFER(100UV		2
	1,20),DIFSQR(100,20),DUMMY1(100,53),DUMMY2(192),FMT6(60),FMT7(60),	UV	3
	2IDLOG2(100,20),NUMBER(20),RANGE(20),SDVMN(20),STDDV(20),SUM(20),	UV	4
	3SUMSQR(20),V(20),X(100,20),XX(100,56),IDLOG(30),DUMMY3(217)	UV	5
C	COMMON K,DUMMY1,NLOG,DUMMY2,IDLOG,DUMMY3,FMT6,FMT7	UV	6
C	DO 43 I = 1,K	UV	7
	DO 43 J = 1,NVAR	UV	8
43	IDLOG2(I,J) = 0	UV	9
	IF (M - 1)28,44,29	UV	10
44	IF (NLOG)34,29,38	UV	11
38	DO 33 J1=1,NLOG	UV	12
	J2 = L + NSPCMP + NSUB + NADD + J1	UV	13
	IF (J2-N1)33,30,30	UV	14
30	IF (J2-N2)31,31,29	UV	15
31	J3 = IDLOG(J1)	UV	16
	J4 = J2-N1 + 1	UV	17
	DO 32 I=1,K	UV	18
	IF (XX(I,J3))34,32,35	UV	19
35	IDLOG2(I,J4) = 1	UV	20
32	CONTINUE	UV	21
33	CONTINUE	UV	22
C	29 DO 1 J=N1,N2	UV	23
	JJ = J - N1 + 1	UV	24
	DO 1 I=1,K	UV	25
1	X(I,JJ) = XX(I,J)	UV	26
	NN1 = 1	UV	27
	NN2 = N2 - N1 + 1	UV	28
C	DO 3 J=NN1,NN2	UV	29
	AMAX(J) = X(1,J)	UV	30
	DO 3 I = 2,K	UV	31
	IF (AMAX(J) - X(I,J))2,3,3	UV	32
2	AMAX(J) = X(I,J)	UV	33
3	CONTINUE	UV	34
C	DO 14 J=NN1,NN2	UV	35
	I = 1	UV	36

	ANUM(J) = 0.	UV	37
	SUM(J) = 0.	UV	38
39	IF (IDLOG2(I,J))28,4,7	UV	39
4	IF (X(I,J))7,5,7	UV	40
5	IF (I-K)6,7,28	UV	41
6	I = I + 1	UV	42
	GO TO 39	UV	43
7	AMIN(J) = X(I,J)	UV	44
	SUM(J) = X(I,J)	UV	45
	ANUM(J) = 1.	UV	46
8	I = I + 1	UV	47
	IF (I - K)40,40,13	UV	48
40	IF (IDLOG2(I,J))28,9,10	UV	49
9	IF (X(I,J))10,8,10	UV	50
10	ANUM(J) = ANUM(J) + 1.	UV	51
	SUM(J) = SUM(J) + X(I,J)	UV	52
	IF (AMIN(J) - X(I,J))8,8,11	UV	53
11	AMIN(J) = X(I,J)	UV	54
12	GO TO 8	UV	55
13	RANGE(J) = AMAX(J) - AMIN(J)	UV	56
14	AMEAN(J) = SUM(J) / ANUM(J)	UV	57
C			
	DO 19 J=NN1,NN2	UV	58
	I = 1	UV	59
	SUMSQR(J) = 0.	UV	60
	IF (IDLOG2(I,J))28,15,17	UV	61
15	IF (X(I,J))17,16,17	UV	62
16	I = I + 1	UV	63
	IF (I - K)15,15,19	UV	64
17	IF (I - K)18,18,19	UV	65
18	DIFFER(I,J) = X(I,J) - AMEAN(J)	UV	66
	DIFSQR(I,J) = DIFFER(I,J) ** 2.	UV	67
	SUMSQR(J) = SUMSQR(J) + DIFSQR(I,J)	UV	68
	GO TO 16	UV	69
19	CONTINUE	UV	70
C			
	DO 20 J=NN1,NN2	UV	71
	STDDV(J) = (SUMSQR(J) / (ANUM(J) - 1.)) ** .5	UV	72
20	V(J) = 100. * STDDV(J) / AMEAN(J)	UV	73
C			
	DO 23 J=NN1,NN2	UV	74
	NUMBER(J) = 0	UV	75
	DO 22 I = 1,K	UV	76
	IF (IDLOG2(I,J))28,42,21	UV	77
42	IF (X(I,J))21,22,21	UV	78
21	NUMBER(J) = NUMBER(J) + 1	UV	79
22	CONTINUE	UV	80
	BNUM(J) = NUMBER(J)	UV	81
23	SDVMN(J) = STDDV(J) / BNUM(J) ** .5	UV	82
C			
24	GO TO (25,26),M	UV	83
25	WRITE OUTPUT TAPE 6,FMT6,(NUMBER(J),J=NN1,NN2),(AMAX(J),J=NN1,NN2)	UV	84

	1, (AMIN(J), J=NN1, NN2), (RANGE(J), J=NN1, NN2), (AMEAN(J), J=NN1, NN2), (STUV	85
	2DDV(J), J=NN1, NN2), (SDVMN(J), J=NN1, NN2), (V(J), J=NN1, NN2)	UV 86
	GO TO 27	UV 87
C		
	26 WRITE OUTPUT TAPE 6, FMT7, (NUMBER(J), J=NN1, NN2), (AMAX(J), J=NN1, NN2) UV	88
	1, (AMIN(J), J=NN1, NN2), (RANGE(J), J=NN1, NN2), (AMEAN(J), J=NN1, NN2), (STUV	89
	2DDV(J), J=NN1, NN2), (SDVMN(J), J=NN1, NN2), (V(J), J=NN1, NN2)	UV 90
	GO TO 27	UV 91
C		
	34 WRITE OUTPUT TAPE 6, 36	UV 92
	CALL EXIT	UV 93
C		
	27 NPTEMP = NPTEMP + 1	UV 94
	N1 = N2 + 1	UV 95
	N2 = N2 + NVAR - 1	UV 96
C		
	36 FORMAT (1H1, 23HANOMALOUS VALUE IN DATA	UV 97
C		
	28 RETURN	UV 98
	END	UV 99
C	- - - - - DASAN (SUBROUTINE BIVAR) - - - - -	
C		
	SUBROUTINE BIVAR (NROW1, NROW2, NPTMP2)	BVRMA 1
C		
	DIMENSION A(20), AMEANX(20), AMEANY(20), B(20), BASE1(20), DIFFER(100, 2BVRMA	2
	1), DIFSQR(100, 2), DRMA(20), DUMMY1(222), DUMMY2(240), DUMMY3(100, 56), FMBVRMA	3
	2T8(96), INDXBV(80, 4), PAIRS(20), R(20), RSQ(20), SPMAX(53), STDDVX(20), BVRMA	4
	3STDDVY(20), STERRA(20), SUM2(2), SUMMUL(20), SUMSQ2(2), TOP1(20), TX(100BVRMA	5
	4, 2), X(100, 53), YMAX1(20), LGCOL(20), DUMMY4(100, 5), SLGMIN(53)	BVRMA 6
C		
	COMMON K, X, NLOG, DUMMY1, NBIVAR, FMT8, DUMMY2, SPMAX, DUMMY3, INDXBV, DUMMBVRMA	7
	1Y4, SLGMIN, NBVT	BVRMA 8
C		
	M = 0	BVRMA 9
	MM = 0	BVRMA 10
	IM = 0	BVRMA 11
	32 DO 16 II = NROW1, NROW2	BVRMA 12
	IF (II - NBVT) 55, 55, 54	BVRMA 13
	55 J1 = INDXBV(II, 1)	BVRMA 14
	J2 = INDXBV(II, 2)	BVRMA 15
	LL = INDXBV(II, 3)	BVRMA 16
	LGT = INDXBV(II, 4)	BVRMA 17
	IF (M) 22, 33, 35	BVRMA 18
	35 IF (INDXBV(II, 4)) 34, 33, 34	BVRMA 19
	34 IM = IM + 1	BVRMA 20
	LGCOL(IM) = LL	BVRMA 21
	33 PAIRS(LL) = 0.	BVRMA 22
	SUMSQ2(1) = 0.	BVRMA 23
	SUMSQ2(2) = 0.	BVRMA 24
	SUM2(1) = 0.	BVRMA 25
	SUM2(2) = 0.	BVRMA 26
	SUMMUL(LL) = 0.	BVRMA 27

C	IF (M)30,41,30	BVRMA 28
41	IF (LGT)29,30,29	BVRMA 29
29	LGT = 0	BVRMA 30
	MM = 1	BVRMA 31
C		
30	Z = 0.	BVRMA 32
	DO 5 I=1,K	BVRMA 33
	IF (LGT)1,2,1	BVRMA 34
1	TX(I,1) = X(I,J1)	BVRMA 35
	TX(I,2) = X(I,J2)	BVRMA 36
	IF (X(I,J1))20,5,24	BVRMA 37
24	IF (X(I,J2))20,5,23	BVRMA 38
23	X(I,J1) = LOG10F(X(I,J1))	BVRMA 39
	X(I,J2) = LOG10F (X(I,J2))	BVRMA 40
	IF (Z) 4,60,4	BVRMA 41
60	IF (SPMAX(J1))20,20,51	BVRMA 42
51	TSPMAX = SPMAX(J1)	BVRMA 43
	SPMAX(J1) = LOG10F(SPMAX(J1))	BVRMA 44
	IF (SPMAX(J2))20,20,61	BVRMA 45
61	TSPMXX = SPMAX(J2)	BVRMA 46
	SPMAX(J2) = LOG10F(SPMAX(J2))	BVRMA 47
	Z = 1.	BVRMA 48
	GO TO 4	BVRMA 49
2	IF (X(I,J1))3,5,3	BVRMA 50
3	IF (X(I,J2))4,5,4	BVRMA 51
4	PAIRS(LL) = PAIRS(LL) + 1.	BVRMA 52
	SUM2(1) = SUM2(1) + X(I,J1)	BVRMA 53
	SUM2(2) = SUM2(2) + X(I,J2)	BVRMA 54
5	CONTINUE	BVRMA 55
C		
	AMEANY(LL) = SUM2(1) / PAIRS(LL)	BVRMA 56
	AMEANX(LL) = SUM2(2) / PAIRS(LL)	BVRMA 57
C		
	DO 6 J=1,2	BVRMA 58
	DO 6 I=1,K	BVRMA 59
	DIFSQR(I,J) = 0.	BVRMA 60
6	DIFFER(I,J) = 0.	BVRMA 61
C		
	DO 9 I = 1,K	BVRMA 62
	IF (LGT)47,7,47	BVRMA 63
47	IF (TX(I,1))20,9,25	BVRMA 64
25	IF (TX(I,2))20,9,10	BVRMA 65
7	IF (X(I,J1))8,9,8	BVRMA 66
8	IF (X(I,J2))10,9,10	BVRMA 67
10	DIFFER(I,1) = X(I,J1) - AMEANY(LL)	BVRMA 68
	DIFFER(I,2) = X(I,J2) - AMEANX(LL)	BVRMA 69
	DIFSQR(I,1) = DIFFER(I,1) ** 2.	BVRMA 70
	DIFSQR(I,2) = DIFFER(I,2) ** 2.	BVRMA 71
9	CONTINUE	BVRMA 72
C		
11	DO 14 I=1,K	BVRMA 73
	DIFMUL = DIFFER(I,1) * DIFFER(I,2)	BVRMA 74

```

SUMMUL(LL) = SUMMUL(LL) + DIFMUL
IF (LGT)26,27,26
26 IF (TX(I,1))20,14,28
28 IF (TX(I,2))20,14,13
27 IF (X(I,J1))12,14,12
12 IF (X(I,J2))13,14,13
13 SUMSQ2(1) = SUMSQ2(1) + DIFSQR(I,1)
SUMSQ2( 2) = SUMSQ2( 2) + DIFSQR(I, 2)
14 CONTINUE

C
STDDVY(LL) = (SUMSQ2(1) / (PAIRS(LL) - 1.)) ** .5
STDDVX(LL) = (SUMSQ2(2) / (PAIRS(LL) - 1.)) ** .5
SY2 = STDDVY(LL) ** 2.
SX2 = STDDVX(LL) ** 2.
R(LL) = SUMMUL(LL) / (SUMSQ2( 1) * SUMSQ2( 2)) ** .5
A(LL) = STDDVY(LL) / STDDVX(LL)
RSQ(LL) = R(LL) ** 2.
STERRA(LL) = A(LL) * ((1. - RSQ(LL)) / PAIRS(LL)) ** .5
B(LL) = AMEANY(LL) - AMEANX(LL) * A(LL)
DRMA(LL) = 100. * (2. * (1.-R(LL)) * (SX2+SY2) / ((AMEANX(LL)**2.)
1 + (AMEANY(LL)**2.))) ** .5
YMAX1(LL) = SPMAX(J2) * A(LL) + B(LL)
IF (LGT)49,48,49
48 VDY = SPMAX(J1) / 49.
GO TO 50
49 VDY = (SPMAX(J1) - SLGMIN(J1)) / 49.
50 TOP1(LL) = (YMAX1(LL) - SPMAX(J1)) / VDY
BASE1(LL) = B(LL) / VDY

C
DO 17 I=1,K
IF (LGT)15,16,15
15 X(I,J1) = TX(I,1)
17 X(I,J2) = TX(I, 2)
SPMAX(J1) = TSPMAX
SPMAX(J2) = TSPMXX
16 CONTINUE
54 NN = NBIVAR

C
IF (M+MM)36,31,36
31 IF (89-K)45,46,46
45 WRITE OUTPUT TAPE 6,19
46 WRITE OUTPUT TAPE 6,18
GO TO 39
36 IF (M)43,42,43
42 IF (70-K)44,46,46
44 WRITE OUTPUT TAPE 6,19
43 WRITE OUTPUT TAPE 6,40,(LGCOL(J),J=1,IM)
39 WRITE OUTPUT TAPE 6,FMT8,(R(J),J=2,NN),(A(J),J=2,NN),(STERRA(J),J=
12,NN),(B(J),J=2,NN),(DRMA(J),J=2,NN),(AMEANY(J),J=2,NN),(AMEANX(J)
2,J=2,NN),(YMAX1(J),J=2,NN),(TOP1(J),J=2,NN),(BASE1(J),J=2,NN)

C
DO 53 J=2,NN

```

BVRMA 75
 BVRMA 76
 BVRMA 77
 BVRMA 78
 BVRMA 79
 BVRMA 80
 BVRMA 81
 BVRMA 82
 BVRMA 83

 BVRMA 84
 BVRMA 85
 BVRMA 86
 BVRMA 87
 BVRMA 88
 BVRMA 89
 BVRMA 90
 BVRMA 91
 BVRMA 92
 BVRMA 93
 BVRMA 94
 BVRMA 95
 BVRMA 96
 BVRMA 97
 BVRMA 98
 BVRMA 99
 BVRMA100
 BVRMA101

 BVRMA102
 BVRMA103
 BVRMA104
 BVRMA105
 BVRMA106
 BVRMA107
 BVRMA108
 BVRMA109

 BVRMA110
 BVRMA111
 BVRMA112
 BVRMA113
 BVRMA114
 BVRMA115
 BVRMA116
 BVRMA117
 BVRMA118
 BVRMA119
 BVRMA120
 BVRMA121

 BVRMA122

```

R(J) = 0. BVRMA123
A(J) = 0. BVRMA124
STERRA(J) = 0. BVRMA125
B(J) = 0. BVRMA126
DRMA(J) = 0. BVRMA127
AMEANY(J) = 0. BVRMA128
AMEANX(J) = 0. BVRMA129
YMAX1(J) = 0. BVRMA130
TOP1(J) = 0. BVRMA131
53 BASE1(J) = 0. BVRMA132
C
  IF (MM)37,38,37 BVRMA133
37 M = 1 BVRMA134
  MM = 0 BVRMA135
  GO TO 32 BVRMA136
38 NPTMP2 = NPTMP2 + 1 BVRMA137
  NROW1 = NROW2 + 1 BVRMA138
  NROW2 = NROW2 + NBIVAR - 1 BVRMA139
  GO TO 22 BVRMA140
C
20 WRITE OUTPUT TAPE 6,21 BVRMA141
  CALL EXIT BVRMA142
C
21 FORMAT(1H1,23HANOMALOUS VALUE IN DATA) BVRMA143
18 FORMAT (1H-,93HBIVARIATE ANALYSIS (REDUCED MAJOR AXIS) OF Y/X. REBVRMA144
  1SULTS NOT VALID FOR COLUMNS OF LOG Y/LOGX.) BVRMA145
19 FORMAT (1H1) BVRMA146
40 FORMAT (1H-,80HBIVARIATE ANALYSIS (REDUCED MAJOR AXIS) OF LOG Y/LOBVRMA147
  1G X VALID ONLY FOR COLUMN(S),10I4/1H,10I4) BVRMA148
C
22 RETURN BVRMA149
  END
C - - - - - DASAN (SUBROUTINE BIVAR) - - - - -
C   ALTERNATE SUBROUTINE BIVAR WHICH COMPUTES
C   THE REGRESSIONS OF Y ON X AND X ON Y.
C - - - - -
C
  SUBROUTINE BIVAR (NROW1,NROW2,NPTMP2) BVYXY 1
C
  DIMENSION AMEANX(20),AMEANY(20),AX(20),AY(20),BASE2(20),BASE3(20),BVYXY 2
1BX(20),BYX(20),CONAX(20),CONAY(20),CONBXY(20),CONBYX(20),DIFFER(1BVYXY 3
200,2),DIFSQR(100,2),DUMMY1(222),DUMMY2(240),DUMMY3(100,56),DUMMY4(BVYXY 4
3100,5),DXY(20),DYX(20),ERRDXY(20),ERRDYX(20),FMT8(96),INDXBV( 80,4BVYXY 5
4),LGCOL(20),PAIRS(20),R(20),RSQ(20),SLGMIN(53),SPMAX(53),STDDVX(20BVYXY 6
5),STDDVY(20),STESTX(20),STESTY(20),SUM2(2),SUMMUL(20),SUMSQ2(2),SXBVYXY 7
6Y(20),SYX(20),TOP2(20),TOP3(20),TX(100,2),X(100,53),XMAX(20),YMAX2BVYXY 8
7(20) BVYXY 9
C
  COMMON K,X,NLOG,DUMMY1,NBIVAR,FMT8,DUMMY2,SPMAX,DUMMY3,INDXBV,DUMMBVYXY 10
1Y4,SLGMIN,NBVT BVYXY 11
C
  M = 0 BVYXY 12

```

MM = 0	BVYXY 13
IM = 0	BVYXY 14
32 DO 16 II = NROW1,NROW2	BVYXY 15
IF (II - NBVT)55,55,54	BVYXY 16
55 J1 = INDXBV(II,1)	BVYXY 17
J2 = INDXBV(II,2)	BVYXY 18
LL = INDXBV(II,3)	BVYXY 19
LGT = INDXBV(II,4)	BVYXY 20
IF (M)22,33,35	BVYXY 21
35 IF (INDXBV(II,4))34,33,34	BVYXY 22
34 IM = IM + 1	BVYXY 23
LGCOL(IM) = LL	BVYXY 24
33 PAIRS(LL) = 0.	BVYXY 25
SUMSQ2(1) = 0.	BVYXY 26
SUMSQ2(2) = 0.	BVYXY 27
SUM2(1) = 0.	BVYXY 28
SUM2(2) = 0.	BVYXY 29
SUMMUL(LL) = 0.	BVYXY 30
C	
IF (M)30,41,30	BVYXY 31
41 IF (LGT)29,30,29	BVYXY 32
29 LGT = 0	BVYXY 33
MM = 1	BVYXY 34
C	
30 Z = 0.	BVYXY 35
DO 5 I=1,K	BVYXY 36
IF (LGT)1,2,1	BVYXY 37
1 TX(I,1) = X(I,J1)	BVYXY 38
TX(I,2) = X(I,J2)	BVYXY 39
IF (X(I,J1))20,5,24	BVYXY 40
24 IF (X(I,J2))20,5,23	BVYXY 41
23 X(I,J1) = LOG10F (X(I,J1))	BVYXY 42
X(I,J2) = LOG10F (X(I,J2))	BVYXY 43
IF (Z) 4,60,4	BVYXY 44
60 IF (SPMAX(J1))20,20,51	BVYXY 45
51 TSPMAX = SPMAX(J1)	BVYXY 46
SPMAX(J1) = LOG10F(SPMAX(J1))	BVYXY 47
IF (SPMAX(J2))20,20,52	BVYXY 48
52 TSPMXX = SPMAX(J2)	BVYXY 49
SPMAX(J2) = LOG10F(SPMAX(J2))	BVYXY 50
Z = 1.	BVYXY 51
GO TO 4	BVYXY 52
2 IF (X(I,J1))3,5,3	BVYXY 53
3 IF (X(I,J2))4,5,4	BVYXY 54
4 PAIRS(LL) = PAIRS(LL) + 1.	BVYXY 55
SUM2(1) = SUM2(1) + X(I,J1)	BVYXY 56
SUM2(2) = SUM2(2) + X(I,J2)	BVYXY 57
5 CONTINUE	BVYXY 58
C	
AMEANY(LL) = SUM2(1) / PAIRS(LL)	BVYXY 59
AMEANX(LL) = SUM2(2) / PAIRS(LL)	BVYXY 60
C	
DO 6 J=1,2	BVYXY 61

	DO 6 I=1,K	BVYXY 62
	DIFSQR(I,J) = 0.	BVYXY 63
	6 DIFFER(I,J) = 0.	BVYXY 64
C		
	DO 9 I = 1,K	BVYXY 65
	IF (LGT)47,7,47	BVYXY 66
47	IF (TX(I,1))20,9,25	BVYXY 67
25	IF (TX(I,2))20,9,10	BVYXY 68
7	IF (X(I,J1))8,9,8	BVYXY 69
8	IF (X(I,J2))10,9,10	BVYXY 70
10	DIFFER(I,1) = X(I,J1) - AMEANY(LL)	BVYXY 71
	DIFFER(I,2) = X(I,J2) - AMEANX(LL)	BVYXY 72
	DIFSQR(I,1) = DIFFER(I,1) ** 2.	BVYXY 73
	DIFSQR(I,2) = DIFFER(I,2) ** 2.	BVYXY 74
	9 CONTINUE	BVYXY 75
C		
11	DO 14 I=1,K	BVYXY 76
	DIFMUL = DIFFER(I,1) * DIFFER(I,2)	BVYXY 77
	SUMMUL(LL) = SUMMUL(LL) + DIFMUL	BVYXY 78
	IF (LGT)26,27,26	BVYXY 79
26	IF (TX(I,1))20,14,28	BVYXY 80
28	IF (TX(I,2))20,14,13	BVYXY 81
27	IF (X(I,J1))12,14,12	BVYXY 82
12	IF (X(I,J2))13,14,13	BVYXY 83
13	SUMSQ2(1) = SUMSQ2(1) + DIFSQR(I,1)	BVYXY 84
	SUMSQ2(2) = SUMSQ2(2) + DIFSQR(I,2)	BVYXY 85
14	CONTINUE	BVYXY 86
C		
	STDDVY(LL) = (SUMSQ2(1) / (PAIRS(LL) - 1.)) ** .5	BVYXY 87
	STDDVX(LL) = (SUMSQ2(2) / (PAIRS(LL) - 1.)) ** .5	BVYXY 88
	BYX(LL) = SUMMUL(LL) / SUMSQ2(2)	BVYXY 89
	BXY(LL) = SUMMUL(LL) / SUMSQ2(1)	BVYXY 90
	AY(LL) = AMEANY(LL) - BYX(LL) * AMEANX(LL)	BVYXY 91
	AX(LL) = AMEANX(LL) - BXY(LL) * AMEANY(LL)	BVYXY 92
	SY2 = STDDVY(LL) ** 2.	BVYXY 93
	SX2 = STDDVX(LL) ** 2.	BVYXY 94
	YY = BYX(LL) ** 2. * SX2	BVYXY 95
	XX = BXY(LL) ** 2. * SY2	BVYXY 96
	SYX(LL) = (PAIRS(LL) - 1.) / (PAIRS(LL) - 2.) * (SY2 - YY)	BVYXY 97
	SXY(LL) = (PAIRS(LL) - 1.) / (PAIRS(LL) - 2.) * (SX2 - XX)	BVYXY 98
	R(LL) = SUMMUL(LL) / (SUMSQ2(1) * SUMSQ2(2)) ** .5	BVYXY 99
	RSQ(LL) = R(LL) ** 2.	BVYXY100
	STESTY(LL) = STDDVX(LL) * (1. - RSQ(LL)) ** .5	BVYXY101
	STESTX(LL) = STDDVY(LL) * (1. - RSQ(LL)) ** .5	BVYXY102
	DXY(LL) = 100. * STESTY(LL) / AMEANX(LL)	BVYXY103
	ERRDXY(LL) = DXY(LL) / (2. * PAIRS(LL)) ** .5	BVYXY104
	DYX(LL) = 100. * STESTX(LL) / AMEANY(LL)	BVYXY105
	ERRDYX(LL) = DYX(LL) / (2. * PAIRS(LL)) ** .5	BVYXY106
	CONBYX(LL) = SYX(LL) ** .5 / (STDDVX(LL) * ((PAIRS(LL) - 1.))**.5))	BVYXY107
	CONBXY(LL) = SXY(LL) ** .5 / (STDDVY(LL) * ((PAIRS(LL) - 1.))**.5))	BVYXY108
	CONAY(LL) = SYX(LL) ** .5 / (PAIRS(LL) ** .5)	BVYXY109
	CONAX(LL) = SXY(LL) ** .5 / (PAIRS(LL) ** .5)	BVYXY110
	XMAX(LL) = SPMAX(J1) * BXY(LL) + AX(LL)	BVYXY111

```

      YMAX2(LL) = SPMAX(J2) * BYX(LL) + AY(LL)
C
      IF (LGT)49,48,49
48  VDY = SPMAX(J1) / 49.
      VDX = SPMAX(J2) / 35.
      GO TO 50
49  VDY = (SPMAX(J1) - SLGMIN(J1)) / 49.
      VDX = (SPMAX(J2) - SLGMIN(J2)) / 35.
50  TOP2(LL) = (YMAX2(LL) - SPMAX(J1)) / VDY
      BASE2(LL) = AY(LL) / VDY
      TOP3(LL) = (XMAX(LL) - SPMAX(J2)) / VDX
      BASE3(LL) = AX(LL) / VDX
C
      IF (LGT)15,16,15
15  DO 17 I=1,K
      X(I,J1) = TX(I,1)
17  X(I,J2) = TX(I,2)
      SPMAX(J1) = TSPMAX
      SPMAX(J2) = TSPMXX
16  CONTINUE
54  NN = NBIVAR
C
      IF (M+MM)36,31,36
31  IF (81-K)45,46,46
45  WRITE OUTPUT TAPE 6,19
46  WRITE OUTPUT TAPE 6,18
      GO TO 39
36  IF (M)43,42,43
42  IF (50-K)44,46,46
44  WRITE OUTPUT TAPE 6,19
43  WRITE OUTPUT TAPE 6,40,(LGCOL(J),J=1,IM)
39  WRITE OUTPUT TAPE 6,FMT8,(R(J),J=2,NN),(BYX(J),J=2,NN),(AY(J),J=2,
1NN),(BXY(J),J=2,NN),(AX(J),J=2,NN),(STESTY(J),J=2,NN),(STESTX(J),J=2,
2=2,NN),(DYX(J),J=2,NN),(ERRDYX(J),J=2,NN),(DXY(J),J=2,NN),(ERRDXY(J),J=2,
3J),J=2,NN),(CONBYX(J),J=2,NN),(CONAY(J),J=2,NN),(CONBXY(J),J=2,NN),
4,(CONAX(J),J=2,NN),(YMAX2(J),J=2,NN),(XMAX(J),J=2,NN),(TOP2(J),J=2,
5,NN),(BASE2(J),J=2,NN),(TOP3(J),J=2,NN),(BASE3(J),J=2,NN)
C
      DO 53 J=2,NN
      R(J) = 0.
      BYX(J) = 0.
      AY(J) = 0.
      BXY(J) = 0.
      AX(J) = 0.
      STESTY(J) = 0.
      STESTX(J) = 0.
      DYX(J) = 0.
      ER RDYX(J) = 0.
      DXY(J) = 0.
      ER RDXY(J) = 0.
      CONBYX(J) = 0.
      CONAY(J) = 0.

```

CONBXY(J) = 0.	BVYXY160
CONAX(J) = 0.	BVYXY161
YMAX2(J) = 0.	BVYXY162
YMAX(J) = 0.	BVYXY163
TOP2(J) = 0.	BVYXY164
BASE2(J) = 0.	BVYXY165
TOP3(J) = 0.	BVYXY166
53 BASE3(J) = 0.	BVYXY167
C	
IF (MM)37,38,37	BVYXY168
37 M = 1	BVYXY169
MM = 0	BVYXY170
GO TO 32	BVYXY171
38 NPTMP2 = NPTMP2 + 1	BVYXY172
NROW1 = NROW2 + 1	BVYXY173
NROW2 = NROW2 + NBIVAR - 1	BVYXY174
GO TO 22	BVYXY175
C	
20 WRITE OUTPUT TAPE 6,21	BVYXY176
CALL EXIT	BVYXY177
C	
21 FORMAT(1H1,23HANOMALOUS VALUE IN DATA)	BVYXY178
18 FORMAT (1H-,107HBIVARIATE ANALYSIS (REGRESSION OF Y ON X AND X ON	BVYXY179
1Y) OF Y/X. RESULTS NOT VALID FOR COLUMNS OF LOG Y/LOG X.)	BVYXY180
19 FORMAT (1H1)	BVYXY181
40 FORMAT (1H-,93HBIVARIATE ANALYSIS (REGRESSION OF Y ON X AND X ON	BVYXY182
1) OF LOG Y/LOG X, VALID ONLY FOR COLUMN(S),7I4/1H ,13I4)	BVYXY183
C	
22 RETURN	BVYXY184
END	

Input Data Preparation for DASAN

The following section describes the preparation of control and data cards and the order in which they are to be placed behind the program source deck. The control cards are described in two groups. Group I is placed directly behind the program source deck and is not repeated for each data deck included in the computer run. Group II follows Group I and must be repeated before each data deck in the run. This means that operations controlled by Group I apply to all data decks in a run, but that operations controlled by each Group II apply only to the data deck immediately following that appearance of Group II.

In the description below, instructions are numbered consecutively. Numbers in parentheses indicate the minimum and maximum numbers of control cards which are permitted for each instruction.

All numbers punched on control cards are without decimal points, unless otherwise indicated, and are right justified within their fields.

The schematic problem illustrated in Figure 1 is used as an example for some of the controls. All instructions are further demonstrated by the listing of controls in the input for a real problem.

Group I Control Cards

1. (1): The number of data decks (from 1 to 999) which are to be processed in a single run. Punch in card columns 1-3.
2. (1): The number of variables in the univariate input array (from 2 to 53), including the column of specimen identification numbers. Punch in columns 2-3.
The number is 6 for the problem in Figure 1.
3. (1): The number of variables in the univariate output array (from 2-53), including the column

of specimen identification numbers. (Note that if the number for Instruction 2 is maximal, i.e., 53, there is no room remaining for additional univariate variables, and the univariate output array will consist only of the array *A* shown in Figure 1.) Punch in columns 2-3.

The number is 13 for the problem in Figure 1.

4. (1): The number of variables in the bivariate array (from 0 to 56), including the column of specimen identification numbers. Punch in columns 2-3.

The number is 9 for the problem in Figure 1.

5. (1): Signal for the calling of Subroutine RAWTAB (one) or the bypassing of RAWTAB (zero), punched in column 3. RAWTAB may be bypassed if no new univariate variables are to be added to the input array.

6. (1): Signal for the calling (one) or bypassing (zero) of Subroutine XRATIO, punched in column 3. XRATIO may be bypassed if no ratios are to be computed and if no bivariate analyses are to be run.

7. (1): (a) *Columns 2-3*: The number of univariate input variables (from 0 to 30) from which a constant, the value of which is specified in Instruction 33, is to be subtracted.

(b) *Columns 5-6*: The number of univariate input variables (from 0 to 30) which are always to be divided by a constant, the value of which is specified in Instruction 34. (See also Instruction 9.)

(c) *Column 9*: The number of univariate input variables (from 0 to 5) which may or may not be divided by the constant referred to above (7b) depending on the value of a signal included with the data for each specimen. (See discussion of data deck in Instructions 21 and 37.)

(d) *Columns 11-12*: The number of univariate variables (from 0 to 30) to be generated by subtracting one input variable from another.

(e) *Columns 14-15*: The number of univariate variables (from 0 to 30) to be generated by adding two input variables.

(f) *Columns 17-18*: The number of univariate variables (from 0 to 30) to be transformed to logarithms to the base 10 and to be added as new columns to the original array.

For the problem in Figure 1, the control card for Instruction 7 is punched 01 01 002 01 02.

8. (0-2): The column numbers of variables in the univariate output array from which a constant, specified in Instruction 33, is to be subtracted. (See also Instruction 7a.) Punch numbers in fields of 3 in columns 1-72.

The card is punched 006 for the problem in Figure 1.

9. (0-2): The column numbers of variables in the univariate output array which are always to be divided by a constant, specified in Instruction 34. (See also Instruction 7b.) Punch numbers in fields of 3 in columns 1-72.

The card is punched 004 for the problem in Figure 1.

10. (0-1): The column numbers of variables in the univariate output array which may or may not be divided by a constant, specified in Instruction 34, depending on a signal read in with the data for each specimen (see Instruction 21). The maximum number of column numbers which can be listed here is 5. Punch numbers in fields of 3 in columns 1-15.

No card is required here for the problem in Figure 1.

11. (0-2): Column numbers of variables in the univariate output array which are to serve as minuends (see Instructions 7d and 12). Punch in fields of 3 in columns 1-72.

The card is punched 002002 for the problem in Figure 1.

12. (0-2): Column numbers of variables in the univariate output array which are to serve as subtrahends, so that the first subtrahend specified here is subtracted from the first minuend specified in Instruction 11, the second subtrahend from the second minuend, etc. Punch numbers in fields of 3 in columns 1-72.

The card is punched 002002 for the problem in Figure 1.

13. (0-2): Column numbers of variables in the univariate output array to which other variables, specified in Instruction 14, are to be added. (See also Instruction 7e.) Punch in fields of 3 in columns 1-72.

The card is punched 005 for the problem in Figure 1.

14. (0-2): Column numbers of variables in the univariate output array which are to be added to variables specified in Instruction 13, such that the first variable specified here is added to the

first variable specified in Instruction 13, the second variable to the second variable, etc. Punch in fields of 3 in columns 1-72.

The card is punched 008 for the problem in Figure 1.

15. (0-2): Column numbers of variables in the univariate output array which are to be transformed to logarithms to the base 10 and which are to be entered as new columns in the univariate output array. (See Instruction 7f.) Punch in fields of 3 in columns 1-72.

The card is punched 002003 for the problem in Figure 1.

16. (1): (a) *Columns 2-3*: The number of univariate variables which are to be fitted on an output page. (This includes a column of specimen identification numbers on each page.)
(b) *Columns 5-6*: The number of segments into which the univariate output array must be broken in order to fit on standard output paper. Each output segment of the array begins with a column occupied by the specimen identification numbers, so that rows in the segment may be readily identified. Calculate the number of segments by means of the following formula:

$$N = \frac{T-C}{C-1} + 1$$

where N , the number of univariate output segments, is rounded to the next highest whole number; T is the number of variables in the univariate output array (Instruction 3); and C is the number of columns which can be fitted on an output page (Instruction 16a).

For the sample output (see listing), T is 6, and C is 14, so that N is 3, after rounding 2.7 to the next highest whole number.

17. (1): (a) *Columns 2-3*: The number of bivariate variables which are to be fitted on an output page. (This includes a column of specimen identification numbers.)
(b) *Columns 5-6*: The number of segments into which the bivariate array must be broken in order to fit on standard output paper. Calculate by means of the formula in Instruction 16b, where T is the total number of variables in the bivariate array (Instruction 4) and C is the number of bivariate columns which are to be fitted on an output page (Instruction 17a).

For the sample output (see listing), T is 42 and C is 12, so that N is 4 after rounding 3.8 to the next highest whole number.

18. (0-10): Indexing of column numbers of variables to be used in computation of ratios, y/x , beginning with the first ratio to appear on the first bivariate output page and proceeding from left to right through consecutive pages. Each ratio is represented by a group of 12 card columns, punched as follows:
(a) *Columns 2-3*: Column number of y in the univariate output array.
(b) *Columns 5-6*: Column number of x in the univariate output array.
(c) *Columns 8-9*: Column number which the ratio will have on its respective output page. (The column of specimen identification numbers is column 1 on each page.)
(d) *Column 12*: Signal for the log (base 10) transformation of both y and x in order to produce bivariate statistics of the ratio both before and after log transformation. Punch zero if no transformation; punch one for transformation.

Indexing for the next ratio begins in the next field of 3 columns, and so on, through the first 72 columns of the card (6 ratios indexed per card). Indexing then begins again on a second card. Because the maximum number of ratios permissible is 55, the maximum number of cards allowed here is 10.

If no ratios are to be computed (i.e., if the control number described in Instruction 4 is zero), no cards should be present for this instruction.

For the schematic problem in Figure 1, two cards would be required which would be punched as follows: first card: 02 03 02 01 03 04 03 01 06 03 04 00 06 05 05 01 09 04 06 01 10 04 07 00; second card: 02 06 08 01 12 13 09 00.

19. (2n): Names of variables to be placed as column headings on each output page. The column headings of each page occupy two cards (columns 1-72 of the first card and columns 1-48 of the second card), with the spacing beginning with card column 1, corresponding to print positions on the output page (120 print positions per line). The names of variables on consecutive pages occupy consecutive pairs of cards. The number of cards required here is

twice the number of output pages. These cards must be present even if they are blank.

20. (1): Numbers of cards to be read in for each of 8 variable formats (Instructions 21-28). Punch in fields of 3 in card columns 1-24. The number of cards for each format must be at least one and cannot exceed 5, with the exception of the eighth format, for which up to 8 cards may be present.
21. (1-5): The format, in FORTRAN II, for the reading in of data cards. The format must begin with a left-parenthesis and end with a right-parenthesis.

If the control described in Instruction 7c is greater than zero, the following applies:

Make provision at the beginning of each data card (or each group of cards if a specimen is represented by more than one card) for reading in the signals which will determine whether certain variables (the column numbers of which were specified in Instruction 10) are to be divided (-1) or not divided (+1) by a constant, the value of which is specified in Instruction 34.

There can be no more than 5 signals, and the signals are to be read in as fixed-point (integer) variables by means of an "I" specification as shown in the format listed with the controls for the sample output. All other variables on the data card must be read in as floating-point variables by means of an "F" or "E" specification.

In addition to the example given by the listing of control cards for the sample input, the following is given:

A data card which is punched, beginning in the first card column, +1-1-1001760321947, and which is read in by the format (3I2, F3.0, 2F3.1, F3.3), will be read in as the following values: +1, -1, -1, 1., 76.0, 32.1, and .947.

For further instruction on format specification in FORTRAN II, particularly with regard to Hollerith "H" specifications and carriage control, the reader is referred to the *FORTRAN General Information Manual* (IBM, 1961) or to McCracken (1961).

22. (1-5): The format, in FORTRAN II, for the punching out of the univariate output array. The order in which the variables are punched

out is the same as the order of the subarrays shown in Figure 1.

This is also the format for the reading in of maxima for the variables in the univariate output array (Instruction 29) and for the reading in of log minima for the variables which will be transformed to logs by Instruction 18d.

23. (1-5): The format, in FORTRAN II, for punching out the bivariate array.
24. (1-5): The format, in FORTRAN II, for printing the univariate output array. The format is repeatedly used for each row of the array throughout all segments, so that the maximum number of decimal places which will be required by any one variable should be used for all variables. The same applies to Instruction 25.
25. (1-5): The format, in FORTRAN II, for the printing of the bivariate array. (See Instruction 24.)
26. (1-5): The format, in FORTRAN II, for printing the univariate statistics beneath each table of the univariate array. Column alignment is achieved by matching the field specifications to those of Instruction 24. Note in the listing of the sample input that an "I" (integer) specification must be used for the row of numbers of non-zero values.
27. (1-5): The format, in FORTRAN II, for printing the univariate statistics beneath each table of the bivariate array, again with "I" specifications for the row of numbers of non-zero values.
28. (1-5): The format, in FORTRAN II, for printing the bivariate statistics beneath each segment of the bivariate array.
29. (1-): Card(s) containing the anticipated maximum values of all the variables in the univariate output array of this run or any future run analyzing the same variables. The maxima are hypothetical and are specified in order to determine the calibration of the axes of the machine-plotted bivariate scatter diagrams, which in turn allows the computation of slopes and intercepts in terms of the scale-units of the diagrams. (See Instructions 11 and 12 in the description of input data for VLOT.) In this manner, the calibration is kept uniform throughout all runs so that the

scatter diagrams for any given ratio can be superimposed for comparison.

The axes of plots of non-log data are assumed to cross at (0,0). For log data, however, the axes may cross at (a,b), where *a* and *b* are minima specified for *x* and *y* on control cards (Instruction 30).

The punching format, and hence the number of cards occupied by the maxima, is determined by Instruction 22. There must be at least one card present, even if no maxima are specified.

30. (1-): Card(s) containing the anticipated minimum log values of those variables which will be transformed to logarithms (base 10) by Instruction 18d. These minima are specified in order to determine the coordinates of the end points of regression lines in terms of scale units of a scatter diagram plotted by VPLOT. Generally the specified log minima are -1. or -2.

The punching format is the same as in Instruction 29, with no data required in the fields of those variables which will not be transformed to logs.

Group II Control Cards

31. (1): (a) *Columns 1-2*: Signal for the punching out of the univariate and bivariate arrays, as follows:

00=no punch-out
+1=punch univariate array only
+2=punch bivariate array only
+3=punch both univariate and bivariate arrays.

(b) *Columns 4-5*: Signal for the printing out of the univariate array and accompanying univariate statistics with the order of the specimens in the data deck preserved:

00=no print-out
+1=print.

(c) *Columns 7-8*: Signal for the printing out of the bivariate array with its accompanying univariate and bivariate statistics, with the order of specimens in the data deck preserved:

00=no print-out
+1=print

(d) *Columns 10-11*: Signal for the printing out of the univariate array and accompanying univariate statistics, with the specimens sorted

according to decreasing values of a univariate variable specified in Instruction 31f:

00=no print-out
+1=print.

(e) *Columns 13-14*: Signal for the printing out of the bivariate array and accompanying univariate and bivariate statistics, with the specimens sorted according to decreasing values of a univariate variable specified in Instruction 31f.

00=no print-out
+1=print

(f) *Columns 16-17*: Column number of a variable in the univariate output array, the decreasing values of which will control the ordering of specimens (rows) in the output, if such output is indicated by the options described in Instructions 31d and 31e.

32. (2): Any name or sample-identification information to be printed at the top of each output page. Punch in columns 1-72 of the first card and columns 1-48 of the second card.

33. (1): A constant which is to be subtracted from certain univariate variables specified in Instruction 8. Punch in columns 1-6 without decimal point. The decimal will be placed by the computer before the last two digits; for example, 017291 will be read in as 172.91.

34. (1): A constant by which certain univariate variables, specified in Instructions 7b and 9, are to be divided. Punch in columns 1-6 in the same manner as the constant described in Instruction 33.

35. (1): A signal allowing for the following choices of lines to be printed at the top of the first output page, below the sample-identification information:

-1: *x* LEFT VALVES
00: *x* SPECIMENS
+1: *x* RIGHT VALVES

where *x* is the number of specimens in the data deck. Punch signal in columns 1-2.

36. (1): The number of specimens (from 1-100) in the data deck. Punch in columns 1-3.

Data Deck

37. The data cards must be punched according to the format specified in Instruction 20. There can be any number of continuation cards for each specimen provided that these are specified by the format.

Alternative Statements and Subroutines for DASAN

Comments following statement No. 28 in Subroutine RAWTAB mark the position in which may be inserted FORTRAN II statements for the computation of special variables. As shown in Figure 1, these variables form a sub-array *B* within the univariate output array. One special-computation statement and the two statements that must accompany it are included in RAWTAB for the purpose of illustration. (The "C" in column 1 makes each of these

statements inoperative in the program.) In this case a variable named "P.AR" in the sample output is computed, where P.AR is the area of a triangle, the base and height of which appear in the univariate output array in columns 21 and 20 respectively. No special control cards are required, but the number of variables in the univariate output array must be increased by 1 for each special computation carried out and adjustments must be made in the output formats.

Sample Input Data for DASAN

Listed below is the entire assembly of data for a test run of DASAN. The problem involves the analysis of 12 specimens, with 28 variables in the univariate input array, 36 variables in the univariate output array, and 42 variables in the bivariate array. The numbers on the far right side of each card refer to instruction numbers in the discussion of input

preparation. Included within the listing (Instruction 28) is the format for the print-out of bivariate statistics involving regressions. The alternative format, to be used with the bivariate subroutine involving the reduced major axis, is shown below the input list.

```
*      DATA
001                                          1
028                                          2
036                                          3
042                                          4
001                                          5
  1                                          6
  01 00  5 02 02 03                          7
012                                          8
013018019020021                          10
006007                                      11
005011                                      12
004008                                      13
002007                                      14
029012006                                  15
014003                                      16
012004                                      17
  06 32 02 00 06 28 03 00 04 02 04 00 05 30 05 00 07 02 06 00 07 32 07 00 18
  08 04 08 00 08 32 09 00 07 08 10 00 33 32 11 00 09 06 12 00 10 06 02 00
  31 07 03 00 14 32 04 00 12 06 05 01 12 32 06 00 13 32 07 00 13 06 08 00
  18 19 09 00 18 06 10 00 20 06 11 00 21 32 12 00 20 21 02 00 22 32 03 00
  23 06 04 00 22 23 05 00 24 06 06 00 25 32 07 00 24 25 08 00 26 06 09 00
  27 32 10 00 05 03 11 00 05 04 12 00 31 02 02 00 34 36 03 00 29 06 04 00
  07 06 05 00 12 28 06 00 02 03 07 00 29 12 08 00 07 28 09 00
SPEC      DG      GP      AD      AK      AM      DF      CD      19
EI        BJ      DE      LO      RIB HT  HI
SPEC      PLICAE  ANTCOS  POSCOS  INTRIB  INTGRV  (AD)    (CE)    (
IK)       (PQ)    (BJ)    (AB)    (MN)    (FG)
SPEC      ALM     P. AREA  KM      EF      AG      CF      LOG P.AR LO
G LO     LOG AM
SPEC      AM/AG    AM/ALM    AD/DG    AK/KM    DF/DG    DF/AG    CD/A
```

```

D      CD/AG      DF/CD      CF/AG      EI/AM
SPEC   BJ/AM      EF/DF      HI/AG      LO/AM      LO/AG      RIBHT/AG      RIBHT/
AM      RIB/GRV    RIB/AM      (AD)/AM      (CE)/AG
SPEC (AD)/(CE)    (IK)/AG      (PQ)/AM      (IK)/(PQ)    (BJ)/AM      (AB)/AG      (BJ)/(
AB) (MN)/AM      (FG)/AG      AK/GP      AK/AD
SPEC   EF/DG      LOG PA/AM      PA/AM      DF/AM      LO/ALM      DG/GP      P.AR/L
O      DF/ALM

```

```

001001001001001003003008
(5I2,F3.0,4F3.1,F4.1,8F3.1,3F2.0,4F3.1/6F3.1,F4.1)
(F4.0,F6.1,12F5.1,9X,1HA/14F5.1,9X,1HB/5F5.1,3F7.4,33X,1HC)
(F4.0,11F6.3,9X,1HA/a2F6.3,7X,1HB/12F6.3,7X,1HC/6F6.3,43X,1HD)
(1HO/(1H ,F4.0,F8.1,12F9.1))
(1HO/(1H ,F4.0,F9.3,10F10.3))
(1H-,4HNUM.,I6,12I9/1H ,4HMAX.,F8.1,12F9.1/1H ,4HMIN.,F8.1,12F9.1/1H , 5
HRANGE,F7.1,12F9.1/1H ,4HMEAN,F8.1,12F9.1/1H 5HSTDDV,F7.1,12F9.1/1H ,5HS
DVMN,F7.1,12F9.1/1H ,3HV ,13F9.1)
(1H-,4HNUM.,I8,10I10/1H ,4HMAX.,F9.3,10F10.3/1H ,4HMIN.,F9.3,10F10.3/1H
,5HRANGE,F8.3,10F10.3/1H ,4HMEAN,F9.3,10F10.3/1H ,5HSTDDV,F8.3,10F10.3/
1H ,5HSDVMN,F8.3,10F10.3/1H ,3HV ,11F10.3)
(1H-,3HR ,11F10.3/1HO,5HA(YX),F8.3,10F10.3/1H ,4HB(Y),F9.3,10F10.3/1HO,
5HA(XY),F8.3,10F10.3/1H ,4HB(X),F9.3,10F10.3/1HO,6HS(Y.X),F7.3,10F10.3/1
H ,6HS(X.Y),F7.3,10F10.3/1HO,6HD(Y.X),F7.3,1CF10.3/1H , 6HS(DYX),F7.3,10
F10.3/1H ,6HD(X.Y),F7.3,10F10.3/1H ,6HS(DXY),F7.3,10F10.3/1HO,6HCONAYX,F
7.3,10F10.3/1H ,5HCONBY,F8.3,10F10.3/1H ,6HCONAXY,F7.3,10F10.3/1H ,5HCON
BX,F8.3,10F10.3/1HO,6HYMAX 2,F7.3,10F10.3/1H ,4HMAX,F9.3,1CF10.3/1HO,6H
TOP YX,F7.3,10F10.3/1H ,6HBASEYX, F7.3,1CF10.3/1H ,6HTOP XY,F7.3,10F10.3
/1H ,6HBASEXY, F7.3,10F10.3)
99.  40.0 40.0 45.0 40.0 75.0 25.0 27.0 14.0 19.5 25.0 26.0  3.5 50.0
30.0 10.0 12.0  5.5  5.0  5.5  6.5 27.0 21.0 31.0 15.0 20.0  9.0100.0
20.0 35.0  6.3 85.0  6.3 1.3010 1.4150 1.8751
98.          -1.0          -1.0

```

```

+3 00 00 +1 +1 06
AEQUIPECTEN NUCLEUS -- MIAMI AND LAKE WORTH, FLA., MCZ 197942,232557,232
553 -- LIVING
000945
002675
+1
012
+1-1-1-1-1 1145130148150 280      80 43 61 66186 1615519 3 4560370410460
340
+1-1-1-1-1 2119110125128 240 72 71 35 61 50174 1313419 3 5390300340390
290
+1-1-1-1-1 3110109117121 219 70 64 30 51 43160 1111521 3 6350240280320
19 260
+1-1-1-1-1 4139141142151 274 89 89 42 69 59184 1515518 3 6410270400410
335
+1-1-1-1-1 5116116121120 239 80 78 38 63 50166 1313421 4 6300250330380
285
+1-1-1-1-1 6127127135141 260 82 79 42 67 56180 1414619 3 6430280380440
315

```

```

+1-1-1-1-1  7123117133129 243 74 72 35 55 50171 1413219 3 6420300350410
              24 290
+1-1-1-1-1  8111105124115 222 70 65 34 59 51162 1312521 3 6350210260320
              270
+1-1-1-1-1  9 99 98100105 193 66 64 31 50 41151 1211120 2 6290180270280
              46 21 220
+1-1-1-1-1 10110111115123 226 68 66 34 50 49161 1212120 3 6350200290310
              66 54 80 49 49 17 270
+1-1-1-1-1 11127121126125 239 86 82 37 68 57185 1414420 3 6450190370520
              85 66 95 49 66 320
+1-1-1-1-1 12126111122130 236 81 76 35 62 60188 1614120 3 6400210410460
              66 27 320

```

```

(1H-,3HR  ,11F10.3/1H0,3HA  ,11F10.3/1H ,6HSIG(A),F7.3,10F10.3/1H0,3HB
,11F10.3/1H0,6HD(RMA),F7.3,10F10.3/1H0,6HMEAN Y,F7.3,10F10.3/1H ,6HMEAN
X,F7.3,10F10.3/1H0,6HYMAX 1,F7.3,10F10.3/1H0,5HTOP 1,F8.3,10F10.3/1H ,6H
BASE 1,F7.3,10F10.3)

```

28

Sample Output from DASAN

Listed below are the punch-outs of the univariate output array and bivariate array and the printed output for the sample problem. In the printed output, variable names consist of at least two letters, with parentheses enclosing letters which represent lower-case letters. The abbreviations for statistics have already been explained in Table 1 and the use of the output in the plotting of reduced major axes and regression lines will be explained at the end of the description of VPLOT.

The specimens, which were ordered from 1 through 12

in the input array, have been rearranged in order of decreasing values of the variable *AM*. As in the simplified sample problem illustrated in Figure 1, certain columns of statistics are not valid. In arrays of bivariate statistics these columns are indicated in output messages. In the arrays of univariate statistics for bivariate data, the statistics for variable No. 36 (*Log P.A./Log AM*) are or may be incorrect.

The bivariate analyses from an additional run using the alternate bivariate subroutine are shown for the second to the last page of the output.

PUNCH-OUT OF UNIVARIATE OUTPUT ARRAY

```

1.  14.5 13.0 14.8 15.0 28.0 -0.  8.0  4.3  6.1  6.6  9.1  1.6 15.5
19.0  3.0  4.0  2.1  1.4  1.5  1.7 -0. -0. -0. -0. -0. -0. 34.0
1.3 13.0  0.  29.3  0.  0.1199 0.9614 1.4472
2.  11.9 11.0 12.5 12.8 24.0  7.2  7.1  3.5  6.1  5.0  7.9  1.3 13.4
19.0  3.0  5.0  1.5  1.1  1.3  1.5 -0. -0. -0. -0. -0. -0. 29.0
0.9 11.2  2.2 24.4 14.3-0.0331 0.9004 1.3802
3.  11.0 10.9 11.7 12.1 21.9  7.0  6.4  3.0  5.1  4.3  6.6  1.1 11.5
21.0  3.0  6.0  1.3  0.9  1.0  1.2 -0. -0. -0. -0. -0. -0. 1.9 26.0
0.6  9.8  2.7 22.7 13.4-0.2034 0.8162 1.3404
4.  13.9 14.1 14.2 15.1 27.4  8.9  8.9  4.2  6.9  5.9  8.9  1.5 15.5
18.0  3.0  6.0  1.5  1.0  1.5  1.5 -0. -0. -0. -0. -0. -0. 33.5
1.1 12.3  3.0 28.1 17.8 0.0592 0.9518 1.4378

```

```

5. 11.6 11.6 12.1 12.0 23.9 8.0 7.8 3.8 6.3 5.0 7.1 1.3 13.4
21.0 4.0 6.0 1.1 0.9 1.2 1.4 -0. -0. -0. -0. -0. -0. 28.5
0.9 11.9 3.0 23.7 15.8-0.0574 0.8543 1.3784
6. 12.7 12.7 13.5 14.1 26.0 8.2 7.9 4.2 6.7 5.6 8.6 1.4 14.6
19.0 3.0 6.0 1.6 1.0 1.4 1.6 -0. -0. -0. -0. -0. -0. 31.5
1.2 11.9 2.6 26.2 16.1 0.0676 0.9320 1.4150
7. 12.3 11.7 13.3 12.9 24.3 7.4 7.2 3.5 5.5 5.0 7.6 1.4 13.2
19.0 3.0 6.0 1.6 1.1 1.3 1.5 -0. -0. -0. -0. -0. 2.4 29.0
1.0 11.4 2.4 25.6 14.6 0.0012 0.8837 1.3856
8. 11.1 10.5 12.4 11.5 22.2 7.0 6.5 3.4 5.9 5.1 6.7 1.3 12.5
21.0 3.0 6.0 1.3 0.8 1.0 1.2 -0. -0. -0. -0. -0. -0. 27.0
0.6 10.7 1.9 23.5 13.5-0.2356 0.8293 1.3464
9. 9.9 9.8 10.0 10.5 19.3 6.6 6.4 3.1 5.0 4.1 5.6 1.2 11.1
20.0 2.0 6.0 1.1 0.7 1.0 1.0 -0. -0. -0. -0. 4.6 2.1 22.0
0.5 8.8 2.5 19.9 13.0-0.2772 0.7520 1.2856
10. 11.0 11.1 11.5 12.3 22.6 6.8 6.6 3.4 5.0 4.9 6.6 1.2 12.1
20.0 3.0 6.0 1.3 0.7 1.1 1.2 6.6 5.4 8.0 4.9 4.9 1.7 27.0
0.6 10.3 1.9 22.5 13.4-0.2019 0.8228 1.3541
11. 12.7 12.1 12.6 12.5 23.9 8.6 8.2 3.7 6.8 5.7 9.1 1.4 14.4
20.0 3.0 6.0 1.7 0.7 1.4 1.9 8.5 6.6 9.5 4.9 6.6 -0. 32.0
1.3 11.4 2.9 25.3 16.8 0.1285 0.9566 1.3784
12. 12.6 11.1 12.2 13.0 23.6 8.1 7.6 3.5 6.2 6.0 9.4 1.6 14.1
20.0 3.0 6.0 1.5 0.8 1.5 1.7 -0. -0. -0. -0. 6.6 2.7 32.0
1.3 10.6 2.1 24.8 15.7 0.1199 0.9708 1.3729

```

PUNCH-OUT OF BIVARIATE ARRAY

```

1. 0.956 0.824 1.021 1.154-0. -0. 0.541 0.273-0. 0. 0.154
0.218-0. 0.529 0.327 0.312 0.055 0.057 1.514 0.075 0.055 0.059 0.891
-0. -0. 0. -0. -0. 0. -0. -0. 1.154 1.014 0. 0.083
0.047-0. 0.269 1.115 0.144-0.
2. 0.984 0.828 1.050 1.143 0.605 0.295 0.568 0.291 1.014 0.586 0.146
0.254 0.306 0.549 0.331 0.326 0.053 0.054 1.300 0.061 0.053 0.060 0.872
-0. -0. 0. -0. -0. 0. -0. -0. 1.164 1.024 0.185-0.024
0.039 0.300 0.274 1.082 0.117 0.248
3. 0.965 0.842 1.064 1.235 0.636 0.308 0.547 0.282 1.094 0.590 0.137
0.233 0.386 0.507 0.299 0.289 0.048 0.050 1.458 0.060 0.048 0.053 0.875
-0. -0. 0. -0. -0. 0. -0. 0.084 1.110 1.034 0.245-0.152
0.029 0.320 0.252 1.009 0.096 0.269
4. 0.975 0.818 1.022 1.228 0.640 0.317 0.627 0.317 1.000 0.633 0.153
0.252 0.337 0.552 0.327 0.319 0.053 0.055 1.519 0.056 0.055 0.055 0.976
-0. -0. 0. -0. -0. 0. -0. -0. 1.071 1.063 0.216 0.041
0.042 0.325 0.267 0.986 0.128 0.266
5. 1.008 0.839 1.043 1.008 0.690 0.338 0.645 0.329 1.026 0.667 0.159
0.264 0.375 0.565 0.299 0.302 0.055 0.054 1.200 0.047 0.052 0.060 0.868
-0. -0. 0. -0. -0. 0. -0. -0. 1.034 0.992 0.259-0.042
0.037 0.335 0.251 1.000 0.123 0.281
6. 0.992 0.825 1.063 1.185 0.646 0.313 0.585 0.302 1.038 0.615 0.162
0.258 0.317 0.557 0.329 0.326 0.053 0.054 1.536 0.062 0.055 0.063 0.864
-0. -0. 0. -0. -0. 0. -0. -0. 1.110 1.044 0.205 0.048
0.045 0.315 0.271 1.000 0.137 0.260
7. 0.949 0.838 1.081 1.132 0.602 0.289 0.541 0.281 1.028 0.570 0.144

```

A
B
C
D
A
B
C
D
A
B
C
D
A
B
C
D
A
B
C
D
A

0.226	0.324	0.516	0.315	0.299	0.055	0.058	1.400	0.065	0.054	0.060	0.854	B
-0.	-0.	0.	-0.	-0.	0.	-0.	0.094	1.103	0.970	0.195	0.001	C
0.041	0.305	0.264	1.051	0.131	0.255							D
8.	0.945	0.822	1.117	1.075	0.631	0.298	0.524	0.277	1.077	0.574	0.153	A
0.266	0.271	0.532	0.304	0.287	0.055	0.059	1.667	0.059	0.044	0.051	0.812	B
-0.	-0.	0.	-0.	-0.	0.	-0.	-0.	1.095	0.927	0.171	-0.175	C
0.026	0.315	0.250	1.057	0.086	0.259							D
9.	0.970	0.877	1.010	1.193	0.667	0.332	0.640	0.322	1.031	0.653	0.161	A
0.259	0.379	0.558	0.293	0.284	0.060	0.062	1.611	0.056	0.052	0.053	0.964	B
-0.	-0.	0.	-0.	-0.	0.	0.238	0.106	1.071	1.050	0.253	-0.216	C
0.027	0.342	0.257	1.010	0.093	0.300							D
10.	1.004	0.837	1.045	1.194	0.618	0.302	0.574	0.293	1.030	0.596	0.150	A
0.221	0.279	0.538	0.294	0.296	0.053	0.053	1.750	0.058	0.048	0.052	0.935	B
0.293	0.239	1.222	0.354	0.218	1.633	0.217	0.076	1.108	1.070	0.173	-0.149	C
0.028	0.301	0.246	0.991	0.094	0.252							D
11.	0.945	0.747	0.992	1.096	0.677	0.340	0.651	0.324	1.049	0.664	0.155	A
0.285	0.337	0.569	0.379	0.358	0.055	0.059	2.368	0.070	0.058	0.077	0.712	B
0.336	0.276	1.288	0.397	0.194	1.939	0.276	-0.	1.033	0.992	0.228	0.093	C
0.056	0.360	0.283	1.050	0.149	0.269							D
12.	0.952	0.737	0.968	1.226	0.643	0.327	0.623	0.306	1.066	0.633	0.148	A
0.263	0.259	0.569	0.396	0.377	0.065	0.068	1.905	0.063	0.065	0.069	0.891	B
-0.	-0.	0.	-0.	-0.	0.	0.280	0.109	1.171	1.066	0.167	0.087	C
0.056	0.343	0.292	1.135	0.141	0.253							D

AEQUIPECTEN NUCLEUS -- MIAMI AND LAKE WORTH, FLA., MCZ 197942,232557,232553 -- LIVING

12 RIGHT VALVES

SPEC	DG	GP	AD	AK	AM	DF	CD	EI	BJ	DE	LO	RIB HT	HI
1.	14.5	13.0	14.8	15.0	28.0	-0.	8.0	4.3	6.1	6.6	9.1	1.6	15.5
4.	13.9	14.1	14.2	15.1	27.4	8.9	8.9	4.2	6.9	5.9	8.9	1.5	15.5
6.	12.7	12.7	13.5	14.1	26.0	8.2	7.9	4.2	6.7	5.6	8.6	1.4	14.6
7.	12.3	11.7	13.3	12.9	24.3	7.4	7.2	3.5	5.5	5.0	7.6	1.4	13.2
2.	11.9	11.0	12.5	12.8	24.0	7.2	7.1	3.5	6.1	5.0	7.9	1.3	13.4
11.	12.7	12.1	12.6	12.5	23.9	8.6	8.2	3.7	6.8	5.7	9.1	1.4	14.4
5.	11.6	11.6	12.1	12.0	23.9	8.0	7.8	3.8	6.3	5.0	7.1	1.3	13.4
12.	12.6	11.1	12.2	13.0	23.6	8.1	7.6	3.5	6.2	6.0	9.4	1.6	14.1
10.	11.0	11.1	11.5	12.3	22.6	6.8	6.6	3.4	5.0	4.9	6.6	1.2	12.1
8.	11.1	10.5	12.4	11.5	22.2	7.0	6.5	3.4	5.9	5.1	6.7	1.3	12.5
3.	11.0	10.9	11.7	12.1	21.9	7.0	6.4	3.0	5.1	4.3	6.6	1.1	11.5
9.	9.9	9.8	10.0	10.5	19.3	6.6	6.4	3.1	5.0	4.1	5.6	1.2	11.1
NUM.	12	12	12	12	12	11	12	12	12	12	12	12	12
MAX.	14.5	14.1	14.8	15.1	28.0	8.9	8.9	4.3	6.9	6.6	9.4	1.6	15.5
MIN.	9.9	9.8	10.0	10.5	19.3	6.6	6.4	3.0	5.0	4.1	5.6	1.1	11.1
RANGE	4.6	4.3	4.8	4.6	8.7	2.3	2.5	1.3	1.9	2.5	3.7	0.5	4.4
MEAN	12.1	11.6	12.6	12.8	23.9	7.6	7.4	3.6	6.0	5.3	7.8	1.4	13.4
STDDV	1.3	1.2	1.3	1.4	2.4	0.8	0.8	0.4	0.7	0.7	1.2	0.2	1.5
SDVMN	0.4	0.3	0.4	0.4	0.7	0.2	0.2	0.1	0.2	0.2	0.4	0.0	0.4
V	10.7	10.2	10.2	10.6	10.0	10.2	11.0	11.6	11.5	13.7	15.9	11.5	10.8

AEQUIPECTEN NUCLEUS -- MIAMI AND LAKE WORTH, FLA., MCZ 197942,232557,232553 -- LIVING

12 RIGHT VALVES

SPEC	PLICAE	ANTCOS	POSCOS	INTRIB	INTGRV	AOI	ICE	LIK	POI	BOI	ABI	MNI	FGI
1.	19.0	3.0	4.0	2.1	1.4	1.5	1.7	-0.	-0.	-0.	-0.	-0.	-0.
4.	18.0	3.0	6.0	1.5	1.0	1.5	1.5	-0.	-0.	-0.	-0.	-0.	-0.
6.	19.0	3.0	6.0	1.6	1.0	1.4	1.6	-0.	-0.	-0.	-0.	-0.	-0.
7.	19.0	3.0	6.0	1.6	1.1	1.3	1.5	-0.	-0.	-0.	-0.	-0.	2.4
2.	19.0	3.0	5.0	1.5	1.1	1.3	1.5	-0.	-0.	-0.	-0.	-0.	-0.
11.	20.0	3.0	6.0	1.7	0.7	1.4	1.9	8.5	6.6	9.5	4.9	6.6	-0.
5.	21.0	4.0	6.0	1.1	0.9	1.2	1.4	-0.	-0.	-0.	-0.	-0.	-0.
12.	20.0	3.0	6.0	1.5	0.8	1.5	1.7	-0.	-0.	-0.	-0.	6.6	2.7
10.	20.0	3.0	6.0	1.3	0.7	1.1	1.2	6.6	5.4	8.0	4.9	4.9	1.7
8.	21.0	3.0	6.0	1.3	0.8	1.0	1.2	-0.	-0.	-0.	-0.	-0.	-0.
3.	21.0	3.0	6.0	1.3	0.9	1.0	1.2	-0.	-0.	-0.	-0.	-0.	1.9
9.	20.0	2.0	6.0	1.1	0.7	1.0	1.0	-0.	-0.	-0.	-0.	4.6	2.1
NUM.	12	12	12	12	12	12	12	2	2	2	2	4	5
MAX.	21.0	4.0	6.0	2.1	1.4	1.5	1.9	8.5	6.6	9.5	4.9	6.6	2.7
MIN.	18.0	2.0	4.0	1.1	0.7	1.0	1.0	6.6	5.4	8.0	4.9	4.6	1.7
RANGE	3.0	2.0	2.0	1.0	0.7	0.6	0.9	1.9	1.2	1.5	0.	2.0	1.0
MEAN	19.7	3.0	5.7	1.5	0.9	1.3	1.5	7.5	6.0	8.7	4.9	5.7	2.2
STDDV	1.0	0.4	0.6	0.3	0.2	0.2	0.3	1.3	0.8	1.1	0.	1.1	0.4
SDVMN	0.3	0.1	0.2	0.1	0.1	0.1	0.1	1.0	0.6	0.7	0.	0.5	0.2
V	4.9	14.2	10.8	18.6	22.6	16.2	18.6	17.8	14.1	12.1	0.	18.9	18.4

AEQUIPECTEN NUCLEUS -- MIAMI AND LAKE WORTH, FLA., MCZ 197942,232557,232553 -- LIVING

12 RIGHT VALVES

SPEC	ALM	P. AREA	KM	EF	AG	LF	LOG P.AK	LOG LO	LOG AM				
1.	34.0	1.3	13.0	0.	29.3	0.	0.1	1.0	1.4	0.	0.	0.	0.
4.	33.5	1.1	12.3	3.0	28.1	17.8	0.1	1.0	1.4	0.	0.	0.	0.
6.	31.5	1.2	11.9	2.6	26.2	16.1	0.1	0.9	1.4	0.	0.	0.	0.
7.	29.0	1.0	11.4	2.4	25.6	14.6	0.0	0.9	1.4	0.	0.	0.	0.
2.	29.0	0.9	11.2	2.2	24.4	14.3	-0.0	0.9	1.4	0.	0.	0.	0.
11.	32.0	1.3	11.4	2.9	25.3	16.8	0.1	1.0	1.4	0.	0.	0.	0.
5.	28.5	0.9	11.9	3.0	23.7	15.8	-0.1	0.9	1.4	0.	0.	0.	0.
12.	32.0	1.3	10.6	2.1	24.8	15.7	0.1	1.0	1.4	0.	0.	0.	0.
10.	27.0	0.6	10.3	1.9	22.5	13.4	-0.2	0.8	1.4	0.	0.	0.	0.
8.	27.0	0.6	10.7	1.9	23.5	13.5	-0.2	0.8	1.3	0.	0.	0.	0.
3.	26.0	0.6	9.8	2.7	22.7	13.4	-0.2	0.8	1.3	0.	0.	0.	0.
9.	22.0	0.5	8.8	2.5	19.9	13.0	-0.3	0.8	1.3	0.	0.	0.	0.
NUM.	12	12	12	11	12	11	12	12	12	0	0	0	0
MAX.	34.0	1.3	13.0	3.0	29.3	17.8	0.1	1.0	1.4	0.	0.	0.	0.
MIN.	22.0	0.5	8.8	1.9	19.9	13.0	-0.3	0.8	1.3	0.	0.	0.	0.
RANGE	12.0	0.8	4.2	1.1	9.4	4.8	0.4	0.2	0.2	0.	0.	0.	0.
MEAN	29.3	1.0	11.1	2.5	24.7	14.9	-0.0	0.9	1.4	0.	0.	0.	0.
STDDV	3.5	0.3	1.2	0.4	2.5	1.6	0.2	0.1	0.0	0.	0.	0.	0.
SDVMN	1.0	0.1	0.3	0.1	0.7	0.5	0.0	0.0	0.0	0.	0.	0.	0.
V	11.9	32.2	10.4	16.6	10.3	10.7	-353.3	8.0	3.2	0.	0.	0.	0.

AEQUIPECTEN NUCLEUS -- MIAMI AND LAKE WORTH, FLA., MCZ 197942,232557,232553 -- LIVING

12 RIGHT VALVES

SPEC	AM/AG	AM/ALM	AD/DG	AK/KM	DF/DG	DF/AG	CD/AD	CD/AG	DF/CD	CF/AG	EI/AM
1.	0.956	0.824	1.021	1.154	-0.	-0.	0.541	0.273	-0.	0.	0.154
4.	0.975	0.818	1.022	1.228	0.640	0.317	0.627	0.317	1.000	0.633	0.153
6.	0.992	0.825	1.063	1.185	0.646	0.313	0.585	0.302	1.038	0.615	0.162
7.	0.949	0.838	1.081	1.132	0.602	0.289	0.541	0.281	1.028	0.570	0.144
2.	0.984	0.828	1.050	1.143	0.605	0.295	0.568	0.291	1.014	0.586	0.146
11.	0.945	0.747	0.992	1.096	0.677	0.340	0.651	0.324	1.049	0.664	0.155
5.	1.008	0.839	1.043	1.008	0.690	0.338	0.645	0.329	1.026	0.667	0.159
12.	0.952	0.737	0.968	1.226	0.643	0.327	0.623	0.306	1.066	0.633	0.148
10.	1.004	0.837	1.045	1.194	0.618	0.302	0.574	0.293	1.030	0.596	0.150
8.	0.945	0.822	1.117	1.075	0.631	0.298	0.524	0.277	1.077	0.574	0.153
3.	0.965	0.842	1.064	1.235	0.636	0.308	0.547	0.282	1.094	0.590	0.137
9.	0.970	0.877	1.010	1.193	0.667	0.332	0.640	0.322	1.031	0.653	0.161
NUM.	12	12	12	12	11	11	12	12	11	11	12
MAX.	1.008	0.877	1.117	1.235	0.690	0.340	0.651	0.329	1.094	0.667	0.162
MIN.	0.945	0.737	0.968	1.008	0.602	0.289	0.524	0.273	1.000	0.570	0.137
RANGE	0.064	0.140	0.149	0.226	0.088	0.051	0.127	0.056	0.094	0.096	0.025
MEAN	0.970	0.820	1.040	1.156	0.641	0.314	0.589	0.300	1.041	0.617	0.152
STDEV	0.023	0.039	0.040	0.069	0.028	0.018	0.046	0.020	0.028	0.036	0.007
SDVMN	0.007	0.011	0.012	0.020	0.008	0.005	0.013	0.006	0.008	0.011	0.002
V	2.338	4.796	3.883	5.986	4.370	5.614	7.826	6.594	2.680	5.768	4.743

BIVARIATE ANALYSIS (REDUCED MAJOR AXIS) OF Y/X. RESULTS NOT VALID FOR COLUMNS OF LOG Y/LOG X.

R	0.974	0.916	0.934	0.832	0.905	0.836	0.730	0.806	0.975	0.844	0.922
A	0.948	0.686	0.983	1.182	0.700	0.357	0.637	0.321	0.936	0.734	0.176
SIG(A)	0.062	0.079	0.102	0.189	0.090	0.059	0.126	0.055	0.063	0.119	0.027
B	0.530	3.821	0.675	-0.310	-0.700	-1.045	-0.623	-0.539	0.757	-2.857	-0.578
D(RMA)	2.297	4.597	3.804	6.091	4.187	5.191	7.637	6.441	2.401	5.276	3.982
MEAN Y	23.925	23.925	12.567	12.817	7.618	7.618	7.383	7.383	7.618	14.945	3.633
MEAN X	24.667	29.292	12.100	11.108	11.882	24.245	12.567	24.667	7.327	24.245	23.925
YMAX 1	81.149	72.454	39.987	41.049	27.302	29.326	28.047	26.760	26.039	59.554	12.624
TOP 1	4.017	-1.664	-5.459	1.286	4.513	8.478	1.900	-0.435	2.037	414.201	-4.814
BASE 1	0.346	2.497	0.735	-0.380	-1.371	-2.048	-1.131	-0.978	1.484	-22.219	-2.024

AEQUIPECIEN NUCLEUS -- MIAMI AND LAKE WORTH, FLA., MCZ 197962,232557,232553 -- LIVING

12 RIGHT VALVES

SPEC	BJ/AM	EF/OF	HI/AG	LO/AM	LO/AG	RIGHT/AG	RIGHT/AM	RIB/GRV	RIB/AM	(AO)/AM	(CE)/AG
1.	0.218	0.	0.529	0.327	0.312	0.055	0.057	1.514	0.075	0.055	0.059
4.	0.252	0.337	0.552	0.327	0.319	0.053	0.055	1.519	0.056	0.055	0.055
6.	0.258	0.317	0.557	0.329	0.326	0.053	0.054	1.536	0.062	0.055	0.063
7.	0.226	0.324	0.516	0.315	0.299	0.055	0.058	1.400	0.065	0.054	0.060
2.	0.254	0.306	0.549	0.331	0.326	0.053	0.054	1.300	0.061	0.053	0.060
11.	0.285	0.337	0.569	0.379	0.358	0.055	0.059	2.368	0.070	0.058	0.077
5.	0.264	0.375	0.565	0.299	0.302	0.055	0.054	1.200	0.047	0.052	0.060
12.	0.263	0.259	0.569	0.336	0.377	0.065	0.068	1.905	0.063	0.065	0.069
10.	0.221	0.279	0.538	0.294	0.296	0.053	0.053	1.750	0.058	0.048	0.052
8.	0.266	0.271	0.532	0.304	0.287	0.055	0.059	1.667	0.059	0.044	0.051
3.	0.233	0.386	0.507	0.299	0.289	0.048	0.050	1.458	0.060	0.048	0.053
9.	0.259	0.379	0.558	0.293	0.284	0.060	0.062	1.611	0.056	0.052	0.053
NUM.	12	11	12	12	12	12	12	12	12	12	12
MAX.	0.285	0.386	0.569	0.396	0.377	0.065	0.068	2.368	0.075	0.065	0.077
MIN.	0.218	0.259	0.507	0.293	0.284	0.048	0.050	1.200	0.047	0.044	0.051
RANGE	0.067	0.126	0.063	0.103	0.093	0.016	0.018	1.168	0.028	0.021	0.026
MEAN	0.250	0.325	0.545	0.324	0.314	0.055	0.057	1.602	0.061	0.053	0.059
SIDDV	0.021	0.044	0.021	0.033	0.029	0.004	0.005	0.307	0.007	0.005	0.008
SOVMN	0.006	0.013	0.006	0.009	0.008	0.001	0.001	0.089	0.002	0.002	0.002
V	8.241	13.457	3.811	10.127	9.189	7.185	8.204	19.178	11.702	10.081	13.138

BIVARIATE ANALYSIS (REDUCED MAJOR AXIS) OF Y/X. RESULTS NOT VALID FOR COLUMNS OF LOG Y/LOG X.

R	0.701	0.621	0.937	0.807	0.850	0.806	0.741	0.675	0.790	0.828	0.743
A	0.285	0.529	0.573	0.514	0.487	0.062	0.065	1.291	0.113	0.086	0.108
SIG(A)	0.059	0.125	0.058	0.088	0.074	0.011	0.013	0.275	0.020	0.014	0.021
B	-0.847	-1.555	-0.694	-4.537	-4.235	-0.165	-0.200	0.257	-1.248	-0.781	-1.188
U(RMA)	7.839	9.537	3.685	6.673	5.961	6.393	7.230	15.990	6.543	5.906	7.397
MEAN Y	5.967	2.473	13.442	7.783	7.783	1.358	1.358	1.464	1.464	1.274	1.464
MEAN X	23.925	7.618	24.667	23.925	24.667	24.667	23.925	0.935	23.925	23.925	24.667
YMAX 1	20.512	11.663	48.018	34.020	37.179	5.085	4.685	6.714	7.255	5.660	7.952
TOP 1	2.542	41.710	-1.943	15.115	21.068	22.191	16.585	10.817	15.632	1.429	10.943
BASE 1	-2.127	-12.095	-0.680	-8.494	-7.981	-2.314	-2.797	2.292	-11.120	-6.954	-8.957

BIVARIATE ANALYSES (REDUCED MAJOR AXIS) OF LOG Y/LOG X, VALID ONLY FOR COLUMNS 5

R	0.701	0.621	0.937	0.835	0.850	0.806	0.741	0.675	0.790	0.828	0.743
A	0.285	0.529	0.573	1.614	0.487	0.062	0.065	1.291	0.113	0.086	0.108
SIG(A)	0.059	0.125	0.058	0.256	0.074	0.011	0.013	0.275	0.020	0.014	0.021
B	-0.847	-1.555	-0.694	-1.336	-4.235	-0.165	-0.200	0.257	-1.248	-0.781	-1.188
U(RMA)	7.839	9.537	3.685	2.929	5.961	6.393	7.230	15.990	6.543	5.906	7.397
MEAN Y	5.967	2.473	13.442	0.886	7.783	1.358	1.358	1.464	1.464	1.274	1.464
MEAN X	23.925	7.618	24.667	1.377	24.667	24.667	23.925	0.935	23.925	23.925	24.667
YMAX 1	20.512	11.663	48.018	1.690	37.179	5.085	4.685	6.714	7.255	5.660	7.952
TOP 1	2.542	41.710	-1.943	5.584	21.068	22.191	16.585	10.817	15.632	1.429	10.943
BASE 1	-2.127	-12.095	-0.680	-27.116	-7.981	-2.314	-2.797	2.292	-11.120	-6.954	-8.957

AEQUIPECTEN NUCLEUS -- MIAMI AND LAKE WORTH, FLA., MCZ 197942,232557,232553 -- LIVING

12 RIGHT VALVES

SPEC	(AD)/(CE)	(IK)/AG	(PQ)/AM	(IK)/(PQ)	(BJ)/AM	(AB)/AG	(BJ)/(AB)	(MN)/AM	(FG)/AG	AK/GP	AK/AD
1.	0.891	-0.	-0.	0.	-0.	-0.	0.	-0.	-0.	1.154	1.014
4.	0.976	-0.	-0.	0.	-0.	-0.	0.	-0.	-0.	1.071	1.063
6.	0.864	-0.	-0.	0.	-0.	-0.	0.	-0.	-0.	1.110	1.044
7.	0.854	-0.	-0.	0.	-0.	-0.	0.	-0.	0.094	1.103	0.973
2.	0.872	-0.	-0.	0.	-0.	-0.	0.	-0.	-0.	1.164	1.024
11.	0.712	0.336	0.276	1.288	0.397	0.194	1.939	0.276	-0.	1.033	0.992
5.	0.868	-0.	-0.	0.	-0.	-0.	0.	-0.	-0.	1.034	0.997
12.	0.891	-0.	-0.	0.	-0.	-0.	0.	0.280	0.109	1.171	1.066
10.	0.935	0.293	0.239	1.222	0.354	0.218	1.633	0.217	0.076	1.138	1.070
8.	0.812	-0.	-0.	0.	-0.	-0.	0.	-0.	-0.	1.095	0.927
3.	0.875	-0.	-0.	0.	-0.	-0.	0.	-0.	0.084	1.110	1.034
9.	0.964	-0.	-0.	0.	-0.	-0.	0.	0.238	0.106	1.071	1.050

NUM.	12	2	2	2	2	2	2	4	5	12	12
MAX.	0.976	0.336	0.276	1.288	0.397	0.218	1.939	0.280	0.109	1.171	1.070
MIN.	0.712	0.293	0.239	1.222	0.354	0.194	1.633	0.217	0.076	1.033	0.927
RANGE	0.264	0.043	0.037	0.066	0.044	0.024	0.306	0.063	0.033	0.138	0.142
MEAN	0.876	0.315	0.258	1.255	0.376	0.206	1.786	0.253	0.093	1.102	1.020
STDDV	0.070	0.030	0.026	0.046	0.031	0.017	0.216	0.030	0.014	0.045	0.044
SOVMN	0.020	0.021	0.019	0.033	0.022	0.012	0.153	0.015	0.006	0.013	0.013
V	7.962	9.581	10.217	3.699	8.188	8.284	12.122	12.024	15.119	4.127	4.264

BIVARIATE ANALYSIS (REDUCED MAJOR AXIS) OF Y/X. RESULTS NOT VALID FOR COLUMNS OF LOG Y/LOGX.

R	0.875	1.000	1.000	1.000	1.000	0.	0.	0.835	0.589	0.921	0.917
A	0.758	0.679	0.923	1.583	1.154	0.	0.	0.510	0.178	1.146	1.060
SIG(A)	0.106	0.000	0.000	0.000	0.000	0.	0.	0.140	0.064	0.129	0.122
B	0.165	-8.668	-15.462	-1.950	-18.077	4.900	8.750	-5.724	-1.957	-0.516	-0.561
DIRMA	8.803	0.002	0.001	0.003	0.001	11.477	14.957	5.900	8.850	4.146	4.224
MEAN Y	1.274	7.550	6.000	7.550	8.750	4.900	8.750	5.675	2.160	12.817	12.817
MEAN X	1.464	23.900	23.250	6.000	23.250	23.900	4.900	22.350	23.100	11.633	12.567
YMAX 1	5.089	49.011	53.769	31.300	68.462	4.900	8.750	32.528	13.191	45.328	47.344
TOP 1	-3.663	39.945	76.462	7.804	59.213	-32.993	-35.169	30.693	22.819	6.527	8.997
BASE 1	1.470	-15.731	-36.077	-3.539	-28.573	16.007	13.831	-14.024	-10.653	-0.633	-0.688

AEQUIPECTEN NUCLEUS -- MIAMI AND LAKE WORTH, FLA., MCZ 197942,232557,232553 -- LIVING

12 RIGHT VALVES

SPEC	EF/OG	LOG PA/AM	PA/AM	OF/AM	LO/ALM	DG/GP	P.AR/LO	OF/ALM			
1.	0.	0.083	0.047	-0.	0.269	1.115	0.144	-0.	0.	0.	0.
4.	0.216	0.041	0.042	0.325	0.267	0.986	0.128	0.266	0.	0.	0.
6.	0.205	0.048	0.045	0.315	0.271	1.000	0.137	0.260	0.	0.	0.
7.	0.195	0.001	0.041	0.305	0.264	1.051	0.131	0.255	0.	0.	0.
2.	0.185	-0.024	0.039	0.300	0.274	1.082	0.117	0.248	0.	0.	0.
11.	0.228	0.093	0.056	0.360	0.283	1.050	0.149	0.269	0.	0.	0.
5.	0.259	-0.042	0.037	0.335	0.251	1.000	0.123	0.281	0.	0.	0.
12.	0.167	0.087	0.056	0.343	0.292	1.135	0.141	0.253	0.	0.	0.
10.	0.173	-0.149	0.028	0.301	0.246	0.991	0.094	0.252	0.	0.	0.
8.	0.171	-0.175	0.026	0.315	0.250	1.057	0.086	0.259	0.	0.	0.
3.	0.245	-0.152	0.029	0.320	0.252	1.009	0.096	0.269	0.	0.	0.
9.	0.253	-0.216	0.027	0.342	0.257	1.010	0.093	0.300	0.	0.	0.
NUM.	11	12	12	11	12	12	12	11	0	0	0
MAX.	0.259	0.093	0.056	0.360	0.292	1.135	0.149	0.300	0.	0.	0.
MIN.	0.167	-0.216	0.026	0.300	0.246	0.986	0.086	0.248	0.	0.	0.
RANGE	0.092	0.309	0.030	0.060	0.046	0.149	0.062	0.052	0.	0.	0.
MEAN	0.209	-0.034	0.039	0.324	0.265	1.041	0.120	0.265	0.	0.	0.
STDEV	0.034	0.112	0.011	0.019	0.014	0.050	0.022	0.015	0.	0.	0.
SOVMN	0.010	0.032	0.003	0.006	0.004	0.014	0.006	0.005	0.	0.	0.
V	16.202	-333.033	26.883	5.982	5.361	4.794	18.509	5.663	0.	0.	0.

BIVARIATE ANALYSIS (REDUCED MAJOR AXIS) OF Y/X. RESULTS NOT VALID FOR COLUMNS OF LOG Y/LOG X.

R	0.388	0.802	0.761	0.815	0.964	0.891	0.970	0.903	0.	0.	0.
A	0.370	3.426	0.128	0.364	0.353	1.095	0.250	0.233	0.	0.	0.
SIGMA	0.103	0.590	0.024	0.064	0.027	0.144	0.017	0.030	0.	0.	0.
B	-1.925	-4.760	-2.112	-0.961	-2.544	-0.644	-0.987	0.885	0.	0.	0.
DIRMA	10.767	7.171	6.990	5.562	3.292	4.900	3.949	5.048	0.	0.	0.
MEAN Y	2.473	-0.043	0.955	7.618	7.783	12.100	0.955	7.618	0.	0.	0.
MEAN X	11.882	1.377	23.925	23.555	29.292	11.633	7.783	28.864	0.	0.	0.
YMAX 1	12.880	1.664	7.503	26.357	32.712	43.174	5.501	24.214	0.	0.	0.
TOP 1	51.179	13.689	-30.618	2.659	12.650	3.888	-35.522	-1.541	0.	0.	0.
BASE 1	-14.973	-179.271	-5.174	-1.884	-4.794	-0.789	-2.418	1.734	0.	0.	0.

BIVARIATE ANALYSIS (REGRESSION OF Y ON X AND X ON Y) OF Y/X. RESULTS NOT VALID FOR COLUMNS OF LOG Y/LOG X.

R	0.388	0.802	0.761	0.815	0.964	0.891	0.970	0.903	0.	0.	0.
A(YX)	0.144	2.749	0.098	0.297	0.340	0.976	0.242	0.211	0.	0.	0.
R(Y)	0.765	-3.828	-1.379	0.622	-2.170	0.750	-0.929	1.540	0.	0.	0.
A(XY)	1.049	0.234	5.937	2.239	2.734	0.813	3.888	3.869	0.	0.	0.
B(X)	9.287	1.387	18.253	6.499	8.013	1.796	4.069	-0.611	0.	0.	0.
S(Y.X)	1.021	0.026	1.558	1.233	0.932	0.539	0.298	1.431	0.	0.	0.
S(X.Y)	0.378	0.090	0.200	0.449	0.329	0.591	0.074	0.334	0.	0.	0.
D(Y.X)	15.283	-210.843	20.905	5.893	4.223	4.881	7.791	4.383	0.	0.	0.
S(QYX)	3.258	-43.038	4.267	1.256	0.862	0.946	1.590	0.934	0.	0.	0.
D(X.Y)	8.593	1.908	6.512	5.233	3.183	4.635	3.832	4.959	0.	0.	0.
S(OXY)	1.832	0.390	1.329	1.116	0.650	0.946	0.782	1.057	0.	0.	0.
CONAYX	0.114	0.647	0.026	0.070	0.030	0.158	0.019	0.033	0.	0.	0.
CONBY	0.120	0.027	0.060	0.143	0.100	0.179	0.023	0.106	0.	0.	0.
CONAXY	0.830	0.055	1.600	0.530	0.239	0.131	0.306	0.615	0.	0.	0.
CONBX	0.325	0.008	0.472	0.392	0.282	0.163	0.090	0.455	0.	0.	0.
YMAX 2	6.514	1.327	5.949	22.899	31.811	39.776	5.366	22.597	0.	0.	0.
XMAX	15.897	1.692	137.000	62.468	79.094	34.317	81.836	96.114	0.	0.	0.
TUP YX	1.667	0.982	-34.450	-4.119	10.952	-0.275	-35.852	-4.710	0.	0.	0.
BASEYX	5.949	-144.160	-3.379	1.219	-4.091	0.919	-2.277	3.019	0.	0.	0.
TUP XY	-21.090	-3.427	28.933	-5.848	-7.317	-4.973	75.164	-1.360	0.	0.	0.
BASEXY	8.127	25.886	8.518	3.033	2.805	1.571	5.477	-0.214	0.	0.	0.

Error Messages in DASAN

Only one error message has been written into DASAN, which reads, ANOMALOUS VALUE IN DATA. This statement will appear and the job will be terminated for any of the following reasons:

1. Control cards contain negative values where these are not allowed.

2. A zero on a card in the data deck has been used as a signal for division by a constant, whereas only a +1 or a -1 is permitted.

3. A variable which is to be converted to a logarithm is negative.

VPLOT: Description of Program

The variable plotting program (VPLOT) provides for very rapid plotting of bivariate scatter diagrams and the construction of reduced major axes or regression lines. The univariate output array of DASAN (Figure 1), or any array in which columns represent variables (measurements) and rows represent specimens, may serve as the input data array. Within VPLOT, this input array is altered and/or expanded to form an *internal data array*. Alterations consist of logarithmic (base 10) transformations of any of the input variables, with the logs replacing the original values. Alternatively, the logs may be entered in new columns of variables, thereby preserving the original values. An alteration of the input array is desirable if only the logs are to be plotted and not the original values. On the other hand, expanding the input array by entering the logs in new columns allows both the original data and the logs to be plotted.

The main routine of VPLOT is concerned with input, with the alteration and expansion of the input array, and with output. The actual plotting of each bivariate scatter diagram is carried out by the subroutine, APLOT, which employs both Boolean algebra and FAP. This subroutine accepts and plots the values in two columns of the internal data array at a time according to column identification numbers specified on control cards.

Listed below are the main steps followed by the program:

VPLOT (main)

1. Control cards, variable format, and data are read in.
2. The value of each input variable (except for the first, which should be a specimen identification number) is compared to a specified minimum value. If below this value, the variable is replaced by the specified minimum.

3. The value of each input variable is compared to a specified maximum value. If greater than this value, the variable is replaced by the specified maximum.

4. Columns of variables, specified on control cards, are replaced by their logarithms (base 10).

5. The logarithms of specified columns of variables are computed and entered as new columns of data.

6. Two variables, designated as x and y on control cards, are entered as arguments in a call to Subroutine APLOT.

Subroutine APLOT

7. One bivariate scatter diagrams is computed, and control is returned to the main program.

VPLOT (main)

8. The scatter diagram computed by APLOT is printed.

9. If more diagrams remain to be plotted, Steps 6 through 8 are repeated for each plot.

10. If more data decks remain in the run, control returns to Step 1 with the reading in of new control cards and data. Otherwise, the job is completed.

Computation Time.—The sample problem described below (12 specimens, 36 input variables, and 43 plots) required only 50 seconds on the IBM 7094. Increasing the number of specimens does not add greatly to the computation time.

Core Space.—The space occupied by VPLOT is not large, but because there are difficulties in plotting points consisting of three digits rather than two, 99 must remain the upper limit of the number of specimens which can be run at a time.

Listing of FORTRAN II Statements in VPLOT

```

C          VARIABLE PLOTTING PROGRAM
C  THOMAS R. WALLER, DEPT. OF PALEOBIOLOGY, SMITHSONIAN INSTITUTION
C          FEBRUARY 6, 1967
C
C  -----
C          VPLOT (MAIN ROUTINE)
C  -----
C
C          DIMENSION X(99,100),A(99),B(99),TAG(100),IDYVAR(20) , IDXVAR(10),XA(VMAIN  1
15),YA(5),FMT(60),ANAME(15),LALCOL(60),LENCOL(60)
C
C          READ INPUT TAPE 5,37,NVAR,NTAG
C          READ INPUT TAPE 5,32,(TAG(J),J=1,NTAG)
C
C  1 READ INPUT TAPE 5,32,ANAME
C    IF (ANAME(1)-(+6HFINISH))2,40,2
C  2 II = 0
C    READ INPUT TAPE 5,37,NS
C    MIN = NS + 1
C    NS2 = NS + 2
C    NS3 = NS + 3
C    K = 0
C    READ INPUT TAPE 5,37,NGROUP
C  3 READ INPUT TAPE 5,31,IDYVAR,IDXVAR,NY,NX,NODATA
C    IF (NODATA)30,4,24
C  4 READ INPUT TAPE 5,37,NFMT
C    KK = 12 * NFMT
C    READ INPUT TAPE 5,32,(FMT(I),I=1,KK)
C    READ INPUT TAPE 5,FMT,((X(I,J),J=1,NVAR), I=1,NS2)
C    READ INPUT TAPE 5,37,LALTER,LENTER
C    IF (LALTER)30,6,5
C  5 READ INPUT TAPE 5,39,(LALCOL(J),J=1,LALTER)
C  6 IF (LENTER)30,41,7
C  7 READ INPUT TAPE 5,39,(LENCOL(J),J=1,LENTER)
C    NVAR1 = NVAR + 1
C    NVAR2 = NVAR + LENTER
C  41 IF (LALTER + LENTER)30,8,45
C  45 READ INPUT TAPE 5,42,(X(NS3,J),J=1,NVAR)
C
C    IF (LALTER)30,18,13
C  13 DO 43 JL=1,LALTER
C    J = LALCOL(JL)
C    DO 16 I=1,NS2
C    IF (X(I,J))30,15,14
C  14 X(I,J) = LOG10(X(I,J))
C    GO TO 16
C  15 X(I,J) = X(NS3,J)
C  16 CONTINUE
C  43 CONTINUE

```

C

```

18 IF (LENTER)30, 8,19
19 J2 = NVAR
   DO 23 JL=1,LENTER
   J = LENCOL(JL)
   J2 = J2 + 1
   DO 22 I=1,NS2
   IF (X(I,J))30,21,20
20 X(I,J2) = LOG10F(X(I,J))
   GO TO 22
21 X(I,J2) = X(NS3,J)
22 CONTINUE
23 CONTINUE

```

C

```

8 DO 46 I=1,NS
  DO 10 J=2,NVAR
  IF (X(I,J)-X(MIN,J))9,10,10
  9 X(I,J) = X(MIN,J)
10 CONTINUE
46 CONTINUE

```

C

```

DO 47 I=1,MIN
DO 12 J=2,NVAR
IF (X(I,J) - X(NS2,J))12,12,11
11 X(I,J) = X(NS2,J)
12 CONTINUE
47 CONTINUE

```

C

```

24 XA(1) = 0.0
   YA91) = 0.0
   II = II + 1

```

C

```

DO 28 M=1,NX
L = IDXVAR(M)
DO 27 J=1,NY
JJ = IDYVAR(J)
IF (JJ - L)25,27,25
25 K = K + 1
DO 26 I=1,NS2
B(I) = X(I,JJ)
26 A(I) = X(I,L)

```

C

```

WRITE OUTPUT TAPE 6,34,NS,ANAME
WRITE OUTPUT TAPE 6,35,K,TAG(JJ)
WRITE OUTPUT TAPE 6,36,TAG(JJ),TAG(L),TAG(L)
CALL APLLOT (1,NS2,1,1,XA,YA,A,B)
27 CONTINUE
28 CONTINUE

```

C

```

IF (NGROUP - II)29,29,3
29 WRITE OUTPUT TAPE 6,33
   GO TO 1
30 WRITE OUTPUT TAPE 6,38

```

C

```

31 FORMAT (20I2,2X,10I2,4X,3I2)
32 FORMAT (12A6)
33 FORMAT (1HL/1HL)
34 FORMAT (1HL,10H PLOT FOR ,I4,16H SPECIMENS      , 15A6)
35 FORMAT (1H0,5X,9HPLOT NO. , I3,40X,11HORDINATE - ,A6)
36 FORMAT (1H0,5X,A6,8H VERSUS ,A6,32X,11HABSCISSA --,A6)
37 FORMAT (I3)
38 FORMAT (1HL,24HNegative VALUE IN INPUT.)
39 FORMAT (36I2)
42 FORMAT (F4.0,9F7.4/(10F7.4))

```

C

```

40 CALL EXIT
END

```

```

SUBROUTINE APLLOT(L,N,NXAXIS,NYAXIS,XA,YA,X,Y)

```

C

```

DIMENSION X(140),Y(140),PLOT(50,12),XA(5),YA(5),OUT(8),B(140),ALPHA
1A(275)

```

C

```

1 FORMAT(1H ,84X5HALPHA,10X14HIDENTIFICATION)
2 FORMAT(1H ,6X1H.,12A6,1H.,11(2XA2))
3 FORMAT(1H ,7X,7(10H+.....),1H+,1H.,1H+)
4 FORMAT(1H ,4XF6.2,4XF6.2,4XF6.2,4XF6.2,4X6.2,4XF6.2,4XF6.2,4XF6.2)
5 FORMAT(1H ,F6.2,1H+,12A6,1H+,11(2XA2))
6 FORMAT( 1H0,2HDX,2XF8.4,2X2HDY,2XF8.4)

```

C

```

LSAV = L
NSAV = N
XL = X(L)
XS = X(L)
YL = Y(L)
YS = Y(L)
N = N+L-1

```

C

```

DO 14 I=L,N
  IF(XL-X(I))7,8,8
7 XL = X(I)
8 IF(XS-X(I))10,10,9
9 XS = X(I)
10 IF(YL-Y(I))11,12,12
11 YL = Y(I)
12 IF(YS-Y(I))14,14,13
13 YS = Y(I)
14 CONTINUE

```

C

```

  IF(XL-XS)102,102,15
15 IF(YL-YS)102,102,16
16 DX = (XL-XS)/35.0
  DY = (YL-YS)/49.0

```

C

```

DO 300 K = 1,50
DO 300 J = 1,12

```

```

300 PLOT(K,J) = (+6H      )
DO 200 I = 1,275
200 ALPHA(I) = (+6H      )
ALPHA(1) = (+6HAAAAAA)
ALPHA(12) = (+6HBEBBBB)
ALPHA(23) = (+6HCCCCCC)
ALPHA(34) = (+6HDDDDDD)
ALPHA(45) = (+6HEEEEEEE)
ALPHA(56) = (+6HFFFFFF)
ALPHA(67) = (+6HGGGGGG)
ALPHA(78) = (+6HHHHHHH)
ALPHA(89) = (+6HJJJJJJ)
ALPHA(100) = (+6HKKKKKK)
ALPHA(111) = (+6HLLLLLL)
ALPHA(122) = (+6HMMMMMM)
ALPHA(133) = (+6HNNNNNN)
ALPHA(144) = (+6HOOOOOO)
ALPHA(155) = (+6HPPPPPP)
ALPHA(166) = (+6HQQQQQQ)
ALPHA(177) = (+6HRRRRRR)
ALPHA(188) = (+6HSSSSSS)
ALPHA(199) = (+6HTTTTTT)
ALPHA(210) = (+6HUUUUUU)
ALPHA(221) = (+6HVVVVVV)
ALPHA(232) = (+6HWWWWW)
ALPHA(243) = (+6HXXXXXX)
ALPHA(254) = (+6HYYYYYY)
ALPHA(265) = (+6HZZZZZZ)
B      B(1) = 000100010001
B      B(2) = 000200020002
B      B(3) = 000300030003
B      B(4) = 000400040004
B      B(5) = 000500050005
B      B(6) = 000600060006
B      B(7) = 000700070007
B      B(8) = 001000100010
B      B(9) = 001100110011
B      B(10) = 010001000100
B      B(11) = 010101010101
B      B(12) = 010201020102
B      B(13) = 010301030103
B      B(14) = 010401040104
B      B(15) = 010501050105
B      B(16) = 010601060106
B      B(17) = 010701070107
B      B(18) = 011001100110
B      B(19) = 011101110111
B      B(20) = 020002000200
B      B(21) = 020102010201
B      B(22) = 020202020202
B      B(23) = 020302030203
B      B(24) = 020402040204

```

```

B      B(25) =020502050205
B      B(26) =020602060206
B      B(27) = 020702070207
B      B(28) =021002100210
B      B(29) =021102110211
B      B(30) = 030003000300
B      B(31) = 030103010301
B      B(32) = 030203020302
B      B(33) = 030303030303
B      B(34) = 030403040304
B      B(35) = 030503050305
B      B(36) = 030603060306
B      B(37) = 030703070307
B      B(38) = 031003100310
B      B(39) = 031103110311
B      B(40) = 040004000400
B      B(41) = 040104010401
B      B(42) = 040204020402
B      B(43) = 040304030403
B      B(44) = 040404040404
B      B(45) = 040504050405
B      B(46) = 040604060406
B      B(47) = 040704070407
B      B(48) = 041004100410
B      B(49) = 041104110411
B      B(50) = 050005000500
B      B(51) = 050105010501
B      B(52) = 050205020502
B      B(53) = 050305030503
B      B(54) = 050405040504
B      B(55) = 050505050505
B      B(56) = 050605060506
B      B(57) = 050705070507
B      B(58) = 051005100510
B      B(59) = 051105110511
B      B(60) = 060006000600
B      B(61) = 060106010601
B      B(62) = 060206020602
B      B(63) = 060306030603
B      B(64) = 060406040604
B      B(65) = 060506050605
B      B(66) = 060606060606
B      B(67) = 060706070607
B      B(68) = 061006100610
B      B(69) = 061106110611
B      B(70) = 070007000700
B      B(71) = 070107010701
B      B(72) = 070207020702
B      B(73) = 070307030703
B      B(74) = 070407040704
B      B(75) = 070507050705
B      B(76) = 070607060706
B      B(77) = 070707070707

```

```

B      B(78) = 071007100710
B      B(79) = 071107110711
B      B(80) = 100010001000
B      B(81) = 100110011001
B      B(82) = 100210021002
B      B(83) = 100310031003
B      B(84) = 100410041004
B      B(85) = 100510051005
B      B(86) = 100610061006
B      B(87) = 100710071007
B      B(88) = 101010101010
B      B(89) = 101110111011
B      B(90) = 110011001100
B      B(91) = 110111011101
B      B(92) = 110211021102
B      B(93) = 110311031103
B      B(94) = 110411041104
B      B(95) = 110511051105
B      B(96) = 110611061106
B      B(97) = 110711071107
B      B(98) = 111011101110
B      B(99) = 111111111111

```

```
IF(NXAXIS)32,32,17
```

C

```

17 DO 31 I = 1,NXAXIS
   IF(XA(I)-XS)31,18,18
18 IF(XA(I)-XL)19,19,31
19 DIFX = XA(I)-XS
   DELX = DX
   J = 1
20 IPOS = 1
21 IF(DIFX-DELX)24,22,22
22 DELX = DELX+DX
   IPOS = IPOS+2
   IF(IPOS-5)21,21,23
23 J = J+1
   GO TO 20
24 GO TO (25,25,27,27,29,29),IPOS
25 DO 26 K = 1,50
26 PLOT(K,J) = (+6H I      )
   GO TO 31
27 DO 28 K = 1,50
28 PLOT(K,J) = (+6H      I  )
   GO TO 31
29 DO 30 K = 1,50
30 PLOT(K,J) = (+6H      I )
31 CONTINUE

```

C

```

32 IF(NYAXIS)41,41,33
33 DO 40 I = 1,NYAXIS
   IF(YA(I)-YS)40,34,34
34 IF(YA(I)-YL)35,35,40

```

```

35 DIFY = YA(I)-YS
   DELY = DY
   K = 1
36 IF(DIFY-DELY)38,37,37
37 DELY = DELY+DY
   K = K+1
   GO TO 36
38 DO 39 J =1,12
39 PLOT(K,J) = (+6H-----)
40 CONTINUE

C
41 DO 88 I = L,N
   DELX = DX
   DELY = DY
   DIFX = X(I)-XS
   DIFY = Y(I)-YS
   J = 1
   K = 1
42 IF(DIFY-DELY)44,43,43
43 DELY = DELY+DY
   K = K+1
   GO TO 42
44 IPOS = 1
45 IF(DIFX-DELX)48,46,46
46 DELX = DELX+DX
   IPOS = IPOS+2
   IF(IPOS-5)45,45,47
47 J = J+1
   GO TO 44
48 GO TO (49,49,62,62,75,75),IPOS
B 49 D = (6060000000000+(7777000000000*PLOT(K,J)))*(-(6060000000000*PLOT(K
   1,J)))
B   E = (4040000000000+(7777000000000*PLOT(K,J)))*(-(4040000000000*PLOT(K
   1,J)))
B   F = (0031000000000+(0077000000000*PLOT(K,J)))*(-(0031000000000*PLOT(K
   1,J)))
B   G = 60000000000*PLOT(K,J)
B   IF(D)50,53,50
B 50 IF(E)51,53,51
B 51 IF(F)52,53,52
B 52 IF(G)57,54,57
B 53 PLOT(K,J) = (000077777777*PLOT(K,J))+(777700000000*B(I))
   GO TO 88
B 54 DO 55 M = 2,266,11
   IF(ALPHA(M)-(+6H      ))55,56,55
55 CONTINUE
   GO TO 88
56 ALPHA(M) = PLOT(K,J)
   ALPHA(M+1) = B(I)
B   PLOT(K,J) = (000077777777*PLOT(K,J))+(777700000000*ALPHA(M-1))
   GO TO 88
57 DO 58 M = 1,265,11
B   IF((777700000000*PLOT(K,J))*(777700000000*(-(ALPHA(M))))))58,59,58

```

```

58 CONTINUE
   GO TO 88
59 JJ = M+2
   KK = M+10
   DO 60 MM = JJ, KK
     IF (ALPHA(MM) - (+6H      )) 60, 61, 60
60 CONTINUE
   GO TO 88
61 ALPHA(MM) = B(I)
   GO TO 88
B 62 D = (000060600000 + (000077770000 * PLOT(K, J))) * (- (000060600000 * PLOT(K
1, J)))
B   E = (000040400000 + (000077770000 * PLOT(K, J))) * (- (000040400000 * PLOT(K
1, J)))
B   F = (000000310000 + (000000770000 * PLOT(K, J))) * (- (000000310000 * PLOT(K
1, J)))
B   G = 000060000000 * PLOT(K, J)
B   IF (D) 63, 66, 63
B 63 IF (E) 64, 66, 64
B 64 IF (F) 65, 66, 65
B 65 IF (G) 70, 67, 70
B 66 PLOT(K, J) = (777700007777 * PLOT(K, J)) + (000077770000 * B(I))
   GO TO 88
67 DO 68 M = 2, 266, 11
   IF (ALPHA(M) - (+6H      )) 68, 69, 68
68 CONTINUE
   GO TO 88
69 A = PLOT(K, J)
   E = 1
   CALL MOVE(A, E, 12, 1)
   ALPHA(M) = E
   ALPHA(M+1) = B(I)
B   PLOT(K, J) = (777700007777 * PLOT(K, J)) + (000077770000 * ALPHA(M-1))
   GO TO 88
70 DO 71 M = 1, 265, 11
B   IF ((000077770000 * PLOT(K, J)) * (000077770000 * (- (ALPHA(M)))) 71, 72, 71
71 CONTINUE
   GO TO 88
72 JJ = M+2
   KK = M+10
   DO 73 MM = JJ, KK
     IF (ALPHA(MM) - (+6H      )) 73, 74, 73
73 CONTINUE
   GO TO 88
74 ALPHA(MM) = B(I)
   GO TO 88
B 75 D = (000000006060 + (000000007777 * PLOT(K, J))) * (- (000000006060 * PLOT(K
1, J)))
B   E = (000000004040 + (000000007777 * PLOT(K, J))) * (- (000000004040 * PLOT(K
1, J)))
B   F = (000000000031 + (000000000077 * PLOT(K, J))) * (- (000000000031 * PLOT(K
1, J)))
B   G = 000000006000 * PLOT(K, J)

```

```

B      IF(D)76,79,76
      76 IF(E)77,79,77
      77 IF(F)78,79,78
      78 IF(G)83,80,83
B      79 PLOT(K,J) = (777777770000*PLOT(K,J))+(000000007777*B(I))
      GO TO 88
      80 DO 81 M = 2,266,11
          IF(ALPHA(M)-(+6H          ))81,82,81
      81 CONTINUE
      GO TO 88
      82 A = PLOT(K,J)
      E = 1
      CALL MOVE(A,E,24,1)
      ALPHA(M) = E
      ALPHA(M+1) = B(I)
B      PLOT(K,J) = (777777770000*PLOT(K,J))+(000000007777*ALPHA(M-1))
      GO TO 88
      83 DO 84 M = 1,265,11
B      IF((000000007777*PLOT(K,J))*(000000007777*(-(ALPHA(M))))))84,85,84
      84 CONTINUE
      GO TO 88
      85 JJ = M+2
      KK = M+10
      DO 86 MM = JJ, KK
          IF(ALPHA(MM)-(+6H          ))86,87,86
      86 CONTINUE
      GO TO 88
      87 ALPHA(MM) = B(I)
      88 CONTINUE

C
      WRITE OUTPUT TAPE 6,1
      K = 50
      P = YL
      L = 41
      B = 40.0
      M=2
      89 IF(M-266)90,90,92
      90 IF(ALPHA(M)-(+6H          ))91,92,91
      91 MM = M-1
      NN = M+9
      WRITE OUTPUT TAPE 6,5,P,(PLOT(K,J),J=1,12),(ALPHA(I),I=MM,NN)
      GO TO 93
      92 WRITE OUTPUT TAPE 6,5,P,(PLOT(K,J),J=1,12)
      93 M = M+11
      K = K-1
      IF(K)100,100,94
      94 IF(K-L)96,95,96
      95 P = YS+(B*DY)
      L = L-10
      B = B-10.0
      GO TO 89
      96 IF(M-266)97,97,99
      97 IF(ALPHA(M)-(+6H          ))98,99,98

```

```

98 MM = M-1
   NN = M+9
   WRITE OUTPUT TAPE 6,2,(PLOT(K,J),J=1,12),(ALPHA(I),I=MM,NN)
   GO TO 93
99 WRITE OUTPUT TAPE 6,2,(PLOT(K,J),J=1,12)
   GO TO 93
100 WRITE OUTPUT TAPE 6,3
   A = 0.0
   DO 101 M = 1,8
   OUT(M) = XS+(A*DX)
101 A = A+5.0
   WRITE OUTPUT TAPE 6,4,(OUT(M),M=1,8)
   WRITE OUTPUT TAPE 6,6,DX,DY
   L = LSAV
   N = NSAV
102 RETURN
   END

```

```

*      FAP
      COUNT 30
      ENTRY      MOVE
MOVE  CLA      2,4
      STA      BB
      CLA      4,4
      STA      HERE
HERE  CLA
      TZE      RITE
      CLA      1,4
      STA      AA
      CLA      3,4
      STA      NEXT
NEXT  CLA
      ARS      18
      STA      NPL
      AA CAL
      NPL ALS
      TOV      BB
      TRA      BB
RITE  CLA      1,4
      STA      AR
      CLA      3,4
      STA      TEMP
TEMP  CLA
      ARS      18
      STA      NPRT
      AR CAL
NPRT  ARS
      BB SLW
      TRA      5,4
      END

```

Input Data Preparation for VPLOT

The following section describes the preparation of control and data cards for VPLOT, using the same conventions as in the previous section describing the input for DASAN. Unlike the previous section, however, a third group of control cards is used. These Group III controls follow each data deck in the run and, like the Group II controls, contain information which affects only the data deck which they accompany. The major groups of cards appearing in a VPLOT run which contains two data decks are ordered as follows:

Program Source Deck
 Group-I Control Cards
 Group-II Control Cards
 Data Deck
 Group-III Control Cards
 Group-II Control Cards (for following data)
 Data Deck
 Group-III Control Cards
 FINISH Card

Group I Control Cards

1. (1): The number of variables in the input data array (from 3 to 100), including the column of specimen identification numbers. Punch in columns 1-3.
2. (1): The number of variables in the internal data array (from 3 to 100), including the column of specimen identification numbers. Punch in columns 1-3.
3. (1-9): Names of variables in the internal data array, with each name not to exceed six characters. Punch in columns 1-72 on each card, 12 names per card, with each name centered in a field of 6 columns, such that the name in the n th field is for the n th column in the array.

Group II Control Cards

4. (2): Any name or sample-identification information to be printed at the top of each output page. Punch in columns 1-72 of first card and columns 1-18 of second card. Both cards must be present even if blank.
5. (1): The number of specimens (from 3 to 97) in the input data array, punched in columns 1-3. The maximum number is 97 rather than the dimensioned 99, because the cards containing the minima (Instruction 11) and maxima (Instruction 12) are read in as data for two additional specimens.

6. (1): The number of plotting groups (from 1 to 999). A plotting group is a series of x and y variables such that each x is plotted against every y , as explained in Instruction 7. Punch in columns 1-3.
7. (1): Information for setting up a plotting group (Instruction 6), to be punched as follows:
 - (a) *Columns 1-40*: The column-identification numbers of the y -variables (from 1 to 20 numbers), with each number in a field of 2 card columns.
 - (b) *Columns 43-62*: The column-identification numbers of the x -variables (from 1 to 10 numbers), with each number in a field of 2 card columns.
 - (c) *Columns 67-68*: The number of y -variables in the plotting group (the number of values punched for Instruction 7a).
 - (d) *Columns 69-70*: The number of x -variables in the plotting group (the number of values punched for Instruction 7b).
 - (e) *Column 72*: Punch a zero if this is the first plotting group preceding the data deck; punch 1 if this is not the first plotting group and it follows the data deck. (See Instruction 18.)
8. (1): The number of cards (from 1 to 5) which are required to specify the format for reading in the data deck. Punch in column 3.
9. (1-5): The format, in FORTRAN II, for the reading in of data cards. (See Instruction 21 in the description of DASAN.) Punch in columns 1-72 of each of the cards needed.

Data Deck

10. See Instructions 21 and 37 in the description of DASAN. The specimen numbers, which form the first column of the data array and which must be read in, are not used by VPLOT. Rather, the specimens are assigned consecutive numbers in their read-in order, beginning with No. 1, and it is these consecutive read-in numbers which appear as the points in the output scatter diagrams.

Group III Control Cards

11. (1-): Cards containing a minimum value for each variable in the input array (see also Instruction 17). The coordinates of the origin of each bivariate scatter diagram are determined by

the minima specified for the x and y variables in each plot. The difference between the minimum and maximum (Instruction 12) specified for each variable determines the scale of calibration of each scatter diagram in which these variables are plotted. (See explanation of sample output from VPLOT.) The cards are read in according to the same format as that used for the reading in of the data deck and must therefore be punched in the same way as the data cards, with a specimen number being entered as the first variable.

12. (1-): Cards containing the anticipated maximum values for each of the variables in the input array, as explained in Instruction 29 in the description of DASAN. These values, together with the minimum values specified for each variable (Instruction 11), determine the scale to which the axes of each of the scatter diagrams are calibrated. These cards are read in according to the same format as that used for the reading in of the data deck and must therefore be punched in the same format as the data cards, with a specimen number being entered as the first variable.
13. (1): The number of columns of variables (from 0 to 60) which are to be replaced by their logarithms (base 10). Punch in columns 2-3.
14. (1): The number of columns of variables (from 0 to 60) which are to be transformed to logarithms, with the logs being entered as new columns of data and the original values being preserved. Punch in columns 2-3.
15. (0-2): Column identification numbers of the variables which are to be replaced by their logarithms. Punch in fields of 2 columns in columns 1-72 of the first card and in columns 1-48 of the second card.
16. (0-2): Column identification numbers of the variables which are to be transformed into logarithms and entered as new columns of data in the internal array. Punch in fields of 2 col-

umns in columns 1-72 of the first card and in columns 1-48 of the second card.

17. (0-7): Cards containing a minimum log value for each variable in the input array which will be transformed to a logarithm and for which a zero minimum was specified in Instruction 11. This log minimum will be inserted by the program into any blank data cells and, like the minima for non-log data described in Instruction 11, will determine the coordinates of the origin and the calibration of the axes of each diagram.

If the minimum specified for a variable in Instruction 11 is greater than zero, the log of this value will become the log minimum, and it is not necessary to specify any new log minimum here. The maximum value for each log variable is the log of its maximum previously specified in Instruction 12.

Punch an imaginary specimen number in columns 1-4 and the log minima in fields of 7 columns in columns 5-67 of the first card and in columns 1-70 of each succeeding card. Consecutive fields represent consecutive columns in the input array, so that a minimum for the 7th variable, for example, must be punched in the field which is in columns 40-46.

The decimal point will be placed by the program in front of the last four digits of each log minimum.

18. If more plotting groups remain, enter one information card (Instruction 7) for each group. Punch as described in Instruction 7, placing a 1 in column 72.
19. If more data decks remain to be processed having the same numbers of variables in the input and internal data arrays and the same names for the variables, begin again with Instruction 4.
20. (1): If no more data decks remain, the last card consists of the word FINISH punched in columns 1-6.

Sample Input Data for VPLOT

Listed below are the control and data cards for a test run of VPLOT, the output from which is discussed in the following section. The input data is the univariate output ar-

ray punched by the preceding test run of DASAN. On the far right side of each control card are numbers which refer to instructions in the section on input preparation.

```

*      DATA
036
041
  SPEC   DG   GP   AD   AK   AM   DF   CD   EI   BJ   DE   LO
  RIBHT  HI  PLICAEANTCOSPOSCOSINTRIBINTGRV (AD) (CE) (IK) (PQ) (BJ)
  (AB) (MN) (FG) ALM P.AREA KM   EF   AG   CF LOGPARLOG LOLOG AM
LOG AMLOG DFLOGPARLOG LOLOGALM
AEQUIPECTEN NUCLEUS -- MIAMI AND LAKE WORTH, FLA., MCZ 197942, 232557,
232553 -- LIVING
012
016
0607083314121321222527          32          1101 0
  1
(F4.0,F6.1,12F5.1,9X,1HA/14F5.1,9X,1HB/5F5.1,3F7.4,33X,1HC)
- - - - - INSERT DATA DECK HERE - - - - -
98.

99.  40.0 40.0 45.0 40.0 75.0 25.0 27.0 14.0 19.5 25.0 26.0  3.5 50.0
30.0 10.0 12.0  5.5  5.5  5.5  6.5 27.0 21.0 31.0 15.0 20.0  9.0100.0
20.0 35.0  6.3 85.0 35.0 1.3010 1.4150 1.8751
00
05
0607291228
  98          -10000 -10000
          -10000
          -10000 -10000

0910121318202324262907          06          1101 1
040731          02          0301 1
060712          28          0301 1
05          30          0101 1
0805          04          0201 1
07          08          0101 1
31          07          0101 1
0502          03          0201 1
18          19          0101 1
20          21          0101 1
22          23          0101 1
24          25          0101 1
39          37          0101 1
29          12          0101 1
3840          37          0201 1
FINISH

```

Sample Output from VPLOT

Reproduced below are two of the plots resulting from an execution of VPLOT involving 12 specimens, with 36 variables in the input array, 41 variables in the internal array, and a total of 43 ratios to be plotted.

PLOT FOR 12 SPECIMENS

AEQUIPECTEN NUCLEUS -- MIAMI AND LAKE WORTH, FLA., MCZ 197942, 232557, 232553 -- LIVING

PLOT NO. 22

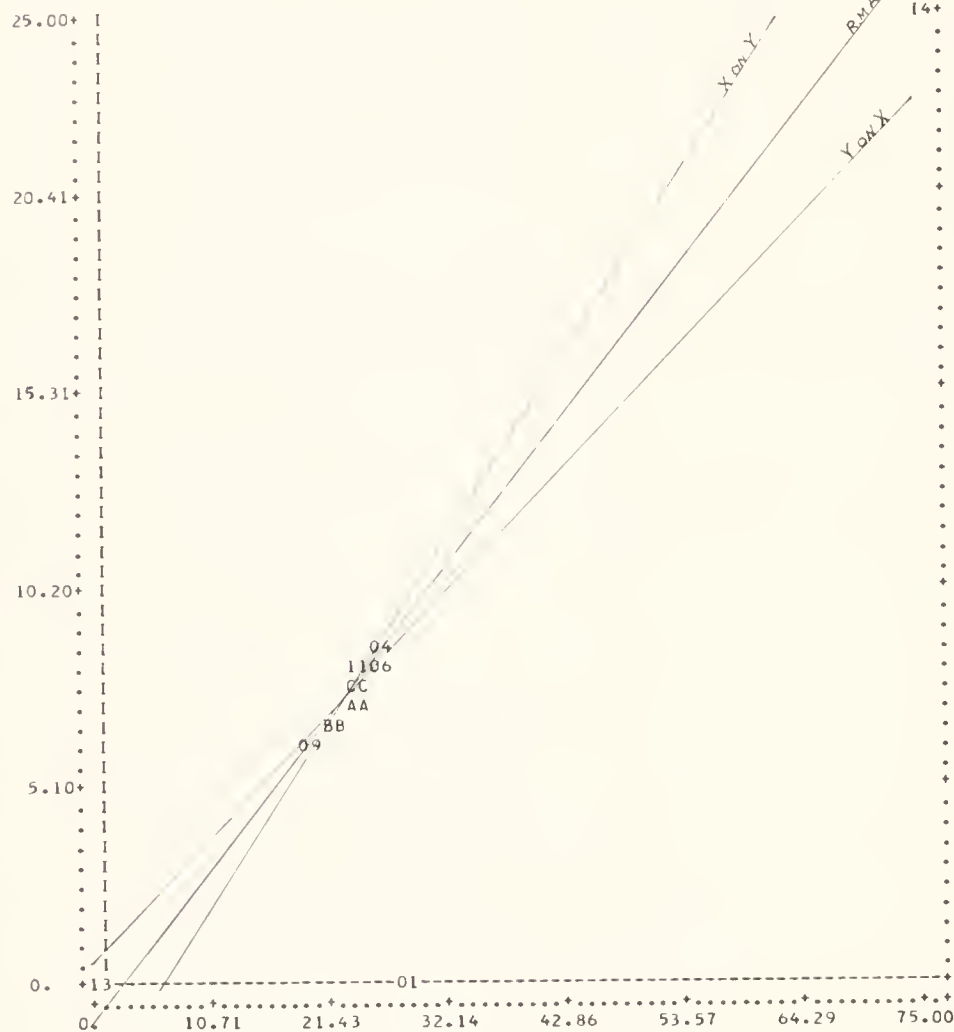
ORDINATE - DF

ABSCISSA -- AM

DF VERSUS AM

ALPHA

IDENTIFICATION



AA	02	07
BB	03	08
CC	05	12

10

DX 2.1429 DY 0.5102

PLOT FOR 12 SPECIMENS AEQUIPECTEN NUCLEUS -- MIAMI AND LAKE WORTH, FLA., MCZ 197942, 232557, 232553 -- LIVING

PLOT NO. 43

LOG LO VERSUS LOG AM

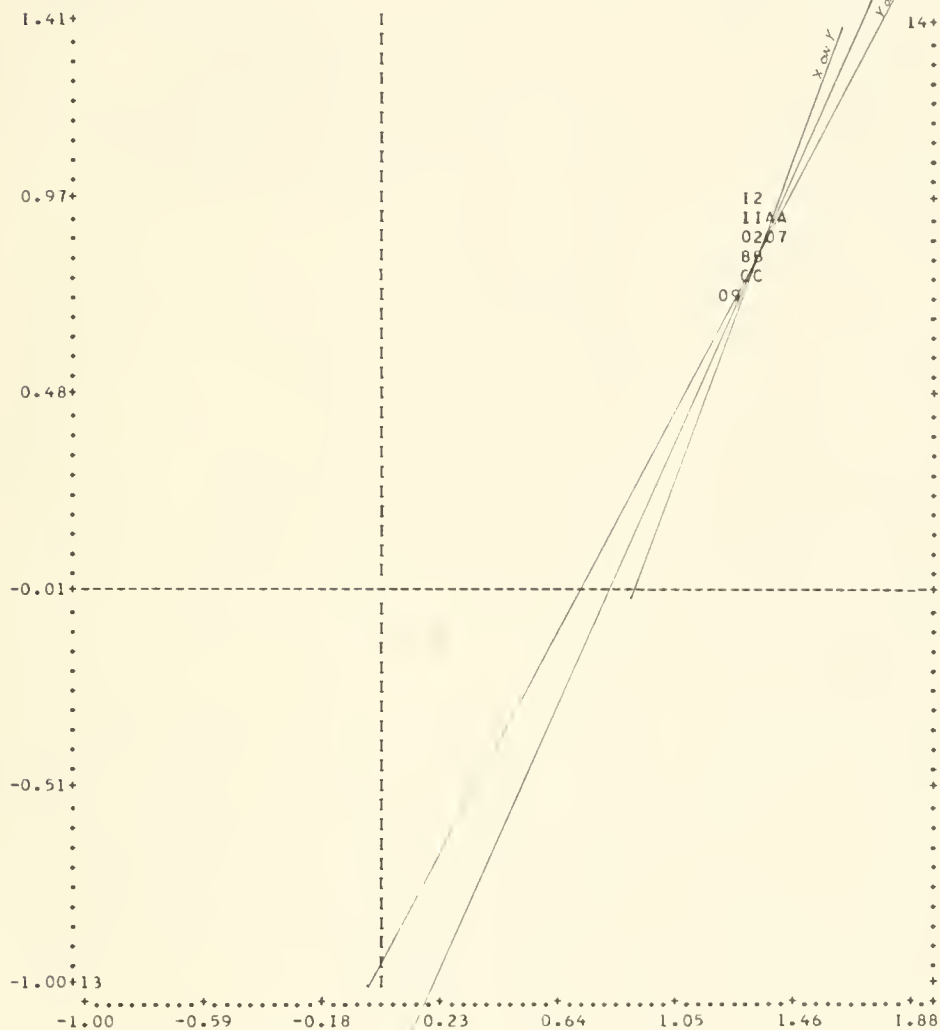
ORDINATE - LOG LC

ABSCISSA -- LOG AM

ALPHA

IDENTIFICATION

ALPHA	01	04	06
AA	01	04	06
BB	05	08	
CC	03	10	



DX 0.0821 DY 0.0493

Each point on the scatter diagram is a two-digit specimen number, with the lower left-hand corner of each two-digit cell representing the actual point. These specimen numbers are *not* the specimen numbers read in with the data, but rather are numbers, from 1 to n , which are assigned to n specimens in the data deck in the order in which they appear in the deck. The arbitrary set of minimum values is also assigned a specimen number, which is $n + 1$, and so also is the set of maximum values, the specimen number of which is $n + 2$. Where two or more points coincide, a double letter is printed, with the specimen numbers of the coincident points printed after the same double letter on the right side of the diagram.

In the sample output, specimens No. 13 and No. 14 represent, respectively, the plots of the specified minimum and maximum for the plotted variables.

The end points of the reduced major axis for the first diagram (DF *versus* AM) are plotted as follows: The y-intercept (the y-coordinate of the point on the reduced major axis where $x=0$), given as BASE 1 in the output of DASAN, is -1.884 . Because this is in the scale units of the diagram, it is only necessary to count down -1.9 dots along an imaginary vertical line through the lower left corner of the two-digit cell occupied by specimen No. 13, which represents the origin. Similarly, the point at which the reduced major axis crosses the right-hand margin of the diagram is indicated in the DASAN output by TOP 1, which is 2.659 . This is plotted by counting 2.7 dots downward along a vertical line through the lower left corner of the two-digit cell occupied by specimen No. 14, the maximal point.

The values DX and DY, printed in the lower right corner of each output page, are, respectively, the values between each dot on the y-axis and between every second dot on

the x-axis. It will be seen that there are 49 such scale-units on the y-axis and 35 on the x-axis between the minimal and maximal points.

The regression of y on x is plotted in the same manner, but the end points of the regression of x on y are given in terms of units on the x-axis rather than on the y-axis. Thus, TOP 3 in the output of DASAN (on the last page of the output listed below) refers to the number of x-axis units to the left (–) or right (+) of point No. 14, and BASE 3 refers to the number of x-axis units to the left (–) or right (+) of point No. 13.

The second diagram shown is a double log plot (LOG LO *versus* LOG AM) in which the coordinates of the specified minimal point are $(-1.0, -1.0)$. Here the basal end points of the reduced major axis and the regression of y on x have been measured along a vertical line through the dot (drawn for the purpose of illustration) which represents the coordinates $(0,0)$. The basal end point of the regression of x on y is measured along a horizontal line through the same dot with measurement in units of the x-axis. The upper end points of all three lines are plotted as in the preceding example.

It will be found that artificially constructed scales matching the spacing of units on the axes will increase the speed and accuracy of line-plotting. When only a small number of points are plotted, there may be an apparent discordance between the plotted points (specimens) and the hand-drawn line of best fit. This is because the two-digit plots are only approximations, the accuracy of which is determined by the print-spacing of the printer, whereas the regression lines and reduced major axis, which are plotted by hand, are limited only by the accuracy of the hand-plotting operation and by the data themselves.

Error Messages in VPLOT

Only one error message has been written into VPLOT, which reads **NEGATIVE VALUE IN INPUT**. It is printed out, and the run is terminated, whenever a negative value

appears where not permitted on a control card or in the data where this value is to be transformed to a logarithm.

Availability of Program Decks

Duplicates of the FORTRAN II source decks may be obtained through the Smithsonian Institution by writing to

the author care of the Department of Paleobiology, Smithsonian Institution, Washington, D.C. 20560.

Literature Cited

IMBRIE, JOHN

1956. Biometrical methods in the study of invertebrate fossils. Bull. Amer. Mus. Nat. Hist., vol. 109, pp. 215-252, figs. 1-10, tables 1-7.

INTERNATIONAL BUSINESS MACHINES CORPORATION

1961. FORTRAN General Information Manual. Edition F28-8074-1, 103 pp.

MCCRACKEN, DANIEL D.

1961. A guide to FORTRAN Programming. New York, John Wiley and Sons, Inc., 88 pp.

SIMPSON, GEORGE G., ANNE ROE, and RICHARD C. LEWONTIN

1960. Quantitative Zoology. Revised edition. New York, Harcourt, Brace and Co., 440 pp.

SMITHSONIAN INSTITUTION LIBRARIES



3 9088 01421 3771